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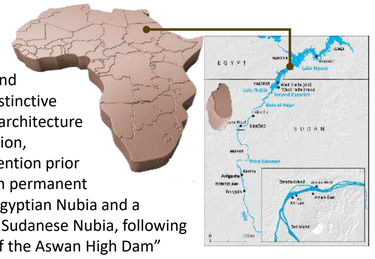
WOMEN & EARTH

Kossi-kossi, Nubian decorative plaster technique

Shadia Abdrabo, Eman A. Selim, Faculty of Archaeology ASU; Ana Michel, Universidad Autónoma de Baja, California; National Corporation for antiquities and museums, Sudan.

TRAINING COURSE , EARTH CONSTRUCTION TECHNIQUES

Context



"Nubia has been celebrated for the creativity and dynamism of its distinctive modern domestic architecture and house decoration, with particular attention prior to the 1960s, when permanent flooding covered Egyptian Nubia and a substantial part of Sudanese Nubia, following the construction of the Aswan High Dam"

(El Hakim 1965; 1999; Fathy 1966)

This traditional technique is practiced in a large part of the Nubian land south from wadi Halfa and extends upstream through Sikood area and the Makas region .

Mud plastering techniques can be found all over the world. One common factor is that decorated mud surfaces are made by women groups.
Kossi Kossi (*KOççı-KOççı*) is a Nubian decorative hand plastering technique, which first came from the Nubian word *Kaci* (to clean) and later became Kossi Kossi (palm leaves) to reflect the pattern representing the date palm branches. According to interviews with old women in Abri, this technique has been practiced for more than 100 years and is used to decorate and to seal hiding holes for scorpions, which are common in the region.

This practice is based on collective work in the villages. Walls, floors and courtyards are plastered by group of women ether just for maintenance or to celebrate special occasions such as weddings, Eid, etc.
Plastering becomes an exciting event mobilizing sisters, friends, relatives and neighbors. As a reward, the owner of the house offers a meal, coffee, tee and cold drinks.

Materials & recipes

This plaster mix is laid by hand with a geometric finger-grooved pattern. One respondent specified a ratio of four buckets of silt, two of dung, ten of sand, and one cup of Arabic gum while another favored equal parts of all three ingredients: mud, dung, sand

4 buckets Silt Design by Ana M. | 10 buckets Sand | 2 buckets Dung | 1 cup arabic gum

Photo © David Gandreau

Photos © Shadia Abdrabo

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Photo ©Matthew Dalton

Photos © Shadia Abdrabo

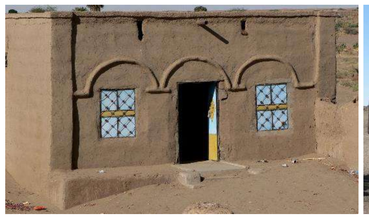

Photo © David Gandreau

Photo © David Gandreau

Evolution & threats

When the old generations of women plastered walls, they used to leave the surface flat, without creating decorative patterns. Adding finger-made patterns is a recent fashion, but the use of the hands as tools has remained the same, as the grandmothers were doing. Highly skilled craftswomen can be recognised by the regularity of their decorations and the darkness of the plaster, which indicates a high quality work. Dark plasters also provide a great contrast with whitewashed surfaces, highlighting architectural details such as window and door frames. Some women have developed such a high reputation that they are called by other families to undertake their household plastering. One woman publicly advertised her services by carving her mobile phone number onto an outdoor mastaba that she had recently re-plastered. (2023 interviews).
The main threats to this cultural practice are climate change and modernisation. Heavy rainfall previously unknown in this climate have started to occur and the positive social image these beautiful walls once carried is fading away, the current high-class style being a cement-coated or ceramic tiled house. If this decoration technique is not passed on to the young generation of women, it will gradually disappear from the cultural landscape, with all the social and economic values it conveys.

Recommendations

This unique traditional technique should be safeguarded for all the values it conveys such as social cohesion, financial resilience, low environmental impact and aesthetic beauty. Community awareness and decoration competitions could be an efficient approach to recreate the local pride for this practice and encourage skill transfers to young women. Once fully revived, this practice could be nominated to the UNESCO world heritage intangible list.

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El Hakim, A. M. (O. M.). 1965. Architectural decoration and its development in the area ofWa iHalfa:A new side of Nubia nart. Occasional Paper 1 (published in Arabic). Khartoum.
Fathy (Fathi), H. 1966. Notes on Nubian architecture. In R. A. Fernea (ed.), Contemporary EgyptianNubia. New Haven, CT, 72–6.
Interviews: Shadia 2023, Matthew Dalton2013.

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Cultura Constructiva en Tierra en el Valle del Itata, Chile

ACEVEDO, ROMINA - SALAS, ANIBAL - RIQUELME, CLAUDIA - TRONCOSO, MATÍAS - TIERRA LAB

CONSERVACIÓN, REHABILITACIÓN Y ADAPTACIÓN DEL PATRIMONIO

Resumen

Esta investigación es el resultado del proyecto de difusión y puesta en valor del patrimonio construido en tierra del Valle del Itata, Chile. Liderado por el equipo de Tierra Lab (laboratorio de investigación y experimentación en torno a la tierra como material óptimo para el Diseño, la arquitectura y la construcción sustentable, ejecutado entre los años 2022-2023 y financiado por el Fondo Nacional de Desarrollo Cultural y las Artes (FONDART) del Ministerio de las Culturas, las Artes y el Patrimonio del Gobierno de Chile. Dando inicio al proyecto de investigación que a través de este de la difusión y puesta en valor de la arquitectura local, busca desarrollar un proceso de mediación con las comunidades que permite ir sentando las bases históricas en relación a como se desarrolló esta cultura constructiva y cuales son esas cualidades características que la hacen única debido a su ubicación en una zona de arquitecturas centenarias en tierra ligadas a la producción vitivinícola.

Introducción

Itata, es el valle vitivinícola más antiguo de Chile, con la llegada de los jesuitas en el siglo XVII se desarrolla un asentamiento marcado por la producción del vino articulando el habitar del territorio en torno a esta matriz productiva. Las materias primas abundantes en este territorio son la tierra, la madera y el agua. De esta forma entre las cuencas del río Itata y del río Biobío, se inscribe la cultura constructiva de tierra más austral de Chile. Las técnicas constructivas de esta zona utilizan la tierra en estado plástico, esto debido a la abundancia de agua del lugar y las condiciones climáticas que permitían su rápido secado. La misma tierra que permitió el desarrollo productivo en torno a los vinos, fué la que permitió habitar del territorio, decantando en diversas técnicas constructivas mixtas en tierra, usos y formas propias de habitar el valle, que han logrado sobrepasar varios terremotos y actualmente incendios forestales.

El propósito de este proyecto es la difusión y puesta en valor de la cultura constructiva en tierra a través de diversos registros que permitieran caracterizarla, identificando las diversas técnicas desarrolladas a lo largo del tiempo, comprendiendo los procesos históricos y socioambientales que han influido en su forma de habitar, desde la mirada de la cultura constructiva, así como su impacto en la identidad y el estilo de vida de los habitantes del valle.

Metodología

Se desarrolla una investigación cuantitativa y cualitativa en terreno a través de recorridos por 4 comunas iniciales; Quillón, Ránquil, Coelemu y Trehuaco, Estos recorridos tienen como objetivo la ejecución de catastros a través de georeferenciación, registro fotográfico, levantamiento planimétrico y observaciones generales y particulares de cada una de las obras visitadas. Permitiendo a través de fichas, definir espacialidades, técnicas constructivas, usos, data, contexto histórico-cultural, entre otros. Para finalizar se hace un registro detallado que permite identificar cuales son las técnicas constructivas que se desarrollaron en el territorio. Todas estas actividades se desarrollan a través de jornadas de participación con las comunidades, entre seminarios, exposiciones fotográficas y conversatorios particulares con las familias propietarias en estas 4 comunas - Quillón, Ranquil, Trehuaco y Coelemu.

Resultados

El proyecto decanta en la recopilación de información de cada comuna y luego de 30 casos de estudio, obras que fueron analizadas en profundidad. Se desarrolló un catastro que permitió identificar 6 técnicas constructivas en tierra, algunas de estas no documentadas en este territorio hasta la fecha, además se logró identificar diferentes escalas de arquitecturas ligadas a los procesos vitivinícolas- Patrimonio modesto con pequeñas bodegas y viviendas de aprox 15m2 a 30m2, Bodegas de vinificación individuales de gran tamaño sobre los 30m2 y luego los conjuntos vitivinícolas con más de 200 años de antigüedad (los conjuntos estaban compuestos por viviendas patronales, bodegas de vinificación, cocinas, casas de trabajadores, caballerizas, entre otros recintos menores) - Toda esta información decanta en una publicación impresa denominada "Cultura constructiva en tierra en el valle del Itata" que será publicada a fines de este 2024 y que incorpora el contexto histórico socio ambiental del cómo se desarrolla está cultura constructiva a lo largo de la historia, catálogo de obras representativas por su espacialidad, uso y técnicas constructivas catastradas que fueron identificadas en el valle del Itata - quincha, adobe, adobe pandereta, Tierras apisonadas, técnica mixta de adobe encofrado, tierra amasada - Y por último el Registro y muestra fotográfico de las arquitecturas y su relación con el territorio.

Conclusiones

En medio del desarrollo del proyecto, el territorio donde se emplaza esta cultura constructiva se vió arrasado por un gigantesco incendio, lo que decantó en varias nuevas demoliciones de este patrimonio. Estas estructuras de tierra que permanecieron erguidas pese al paso del fuego, pero que por desconocimiento y falta de apoyo técnico algunas de estas lamentablemente fueron demolidas por el miedo de derrumbe, de ahí la importancia de mediación con las familias propietarias y la comunidad que permita poner en valor la historia e identidad que estas construcciones representan para este territorio. Dentro de los hallazgos más importantes, fué de reconocer técnicas constructivas no catastradas anteriormente en esta zona y por otro lado se logró identificar agrupaciones arquitectónicas vitivinícolas en tierra con características particulares que solo se encuentran en este valle del país.

Para el equipo los procesos de mediación y de difusión del patrimonio local con las propias comunidades fué lo más relevante del proyecto, ya que mucho de este patrimonio está abandonado o dejando su uso fundacional por la pérdida de la forma del habitar del territorio producto de la masificación de la industria forestal, desplazando a sus habitantes a zonas urbanas modificando sus formas de vida. La difusión y puesta en valor de este patrimonio, nos ayudó también a comprender que es una cultura constructiva viva que está en proceso de adaptación y que en casi todas las comunas que se trabajaron encontramos nuevas arquitecturas contemporáneas reinterpretando estás técnicas constructivas patrimoniales.

Fig.2. Fundo VItivinícola año 1870 Familia Rössle

Fig.3. Vivienda de quincha 1920. Capilla Ranquil

Fig.4. Bodega de vinificación, Ñipas. 1850aprox

Fig.5 Bodega de vinificación patrimonio modesto ñipas. 1950 aprox

Fig.1. Recorridos comunitarios patrimoniales Capilla de Ranquil.

Fig.6. Fundo Vitivinícola la quinta. 1870aprox

Fig.7. Bodega Valle de Chekura, Guarilihue. Año1940

Ministerio de las Culturas, las Artes y el Patrimonio
Gobierno de Chile

Proyecto financiado por FONDART Nacional, Linea circulación internacional de contenidos 2023 Folio:734964

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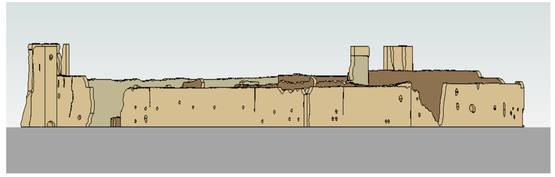
Low-cost Digital Documentation
using mobiles & Laptops

Eman A. Selim (Consrvator) ,Heba A. Moawad (Documentation Specialist) , Mahmoud S. Mostafa (Archaeologist), Faculty of Archaeology - ASU

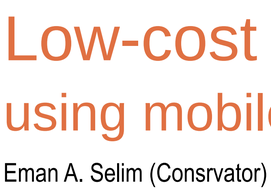
TRAINING COURSE , EARTH CONSTRUCTION TECHNIQUES

Introduction

The castle of Sheikh al-Arab Hammam is located in the Qena governorate, near the village of Al-Araki, about 6 km southwest of Farshut, Egypt. The area covers 53 acres. Sheikh al-Arab Hammam was a famous governor in upper Egypt who was born in 1709 in Farshut and died in 1769.

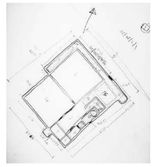


Physical documentation is a record of the monument which provides all the data showing the state of conservation, before, during and after the conservation process.
Documentation is an important step in the conservation cycle. It helps to take decisions on maintenance and preservation of the monuments. The documentation technique described in this poster focusses on the physical survey only. It can be completed with other studies on materials, know how etc.



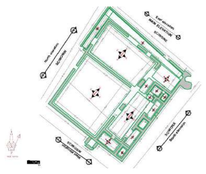
Documentation Process

The archaeological map of this castle was completed in one day.
At the end of the day, the plan and elevations were available.
After a week, the 3D model was ready. These supports are efficient tools for heritage professionals.



Freehand drawing

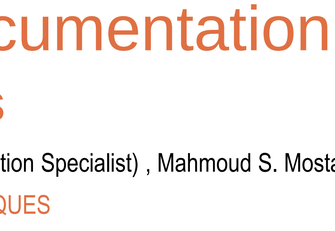
Google Earth



Coding Plan (AutoCAD)

Documentation steps

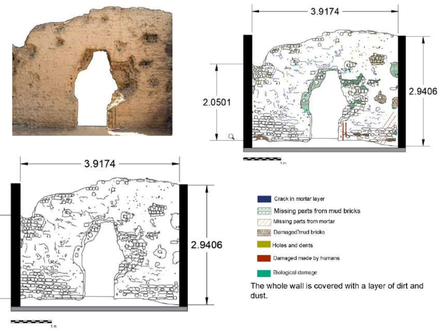
STEP 1 Taking photos



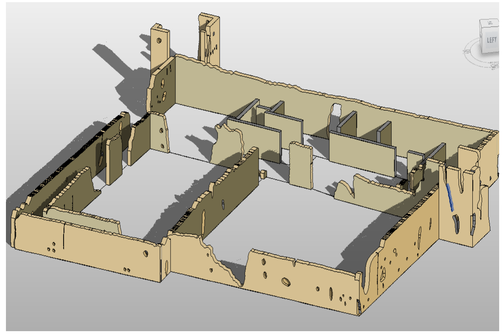
STEP 2 Photos transfer

STEP 3 Using Photoshop to merge and edit images

STEP 4 Using the AutoCAD program for 2D drawing and Deterioration map

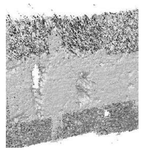


STEP 5 **Revit software (3D modeling)**



STEP 6 **Photogrammetry (3D software)**

Build Dense Cloud



Build Mesh

Build Texture

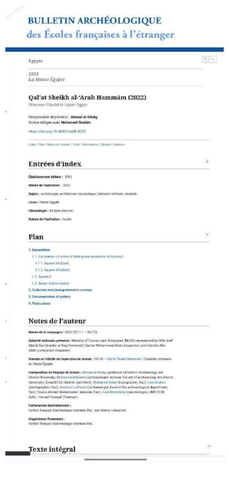
Crypte Saint Oyand, Grenoble
Designed by Heba M. 17.06.24
Device: Mobile phone and Agisoft software (534 photo)

QR code for 3D modeling

Case study

Beneficiaries

This process can serve each of the archaelogical, Academic and civil communities.



Roman site in Vienne, France
Designed by Heba M. 12.06.24
Device: Mobile phone and Agisoft software (238 photo)

Roman site in Vienne, France
Designed by Heba M. 12.06.24
Device: Mobile phone and Agisoft software (337 photo)

Accessibility self-Learning

Revit tutorial

Agisoft tutorial

Agisoft software

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UNESCO CHAIR earthen architecture, building cultures and sustainable development

2-4 July 2024
Grenoble (FRANCE)

Levantamiento Arquitectónico y Cultura Constructiva de la Vivienda Vernácula en Marchigüe, Chile.

MARGARITA CÁCERES CONTRERAS – PANGEA FUNDACIÓN

TEMA 1 / CONSERVACIÓN, REHABILITACIÓN Y ADAPTACIÓN DEL PATRIMONIO

Esta investigación y su circulación fue financiada por el Fondo Nacional de Desarrollo Cultural y las Artes. FONDART Regional, Cultura Tradicional y Popular, convocatoria 2022 y FONDART Nacional de Circulación Nacional e Internacional convocatoria 2024 del Ministerio de las Culturas, las Artes y el Patrimonio del Gobierno de Chile.

Resumen

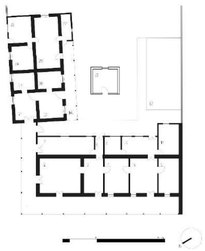
Las viviendas vernáculas de tierra de Marchigüe, son obras irrepetibles, construidas por la propia voluntad y necesidad de los campesinos, en una época, s. XIX y XX, donde la seguridad social era inexistente. Aún quedan vivas algunas de las personas conocedoras de la historia y las técnicas, descendientes de los autores de estas obras.
La investigación aquí expuesta parte del análisis arquitectónico- constructivo enlazado con relatos del habitar y del oficio, para finalmente concluir que lo trascendente es el sujeto que mantiene viva una cultura constructiva, que es capaz de reparar y adaptar sin dañar la vivienda para que esta permanezca vigente. Esta investigación es un trabajo exploratorio y un primer aporte a la conservación, rehabilitación y adaptación del patrimonio en Marchigüe, Chile.

Introducción

Las viviendas de adobe, son el testimonio construido de la historia e identidad de Marchigüe, una pequeña comuna del agroecosistema del secano costero de la región de O´Higgins, Chile, cuya arquitectura es representativa de la "cultura constructiva del valle central de Chile" (Jorquera,2022. p.165).

Diversos cambios socioculturales han mermado su correcta construcción y mantención, dejando este patrimonio en riesgo de desaparecer. En este contexto, la presente investigación tiene como objetivo poner en valor la vivienda vernácula del habitante común, existente en el área urbana y rural de Marchigüe, que se caracterizó por el uso de mampostería de adobe. Es un tema relevante ya que si bien en Chile hay mucho registro sobre las casonas de haciendas coloniales, la vivienda de los campesinos, construida a pulso con los materiales locales ha sido poco visibilizada por las políticas públicas.

El proyecto nace desde el interés de Pangea Fundación por documentar el patrimonio vernáculo considerando la vulnerabilidad de las viviendas de la zona central de Chile posterior al terremoto del 2010 y desde una profunda admiración por los cultores vivos del oficio de adobero. Equipo ejecutor: Margarita Cáceres, Santiago Naudón y Marcela Serrano.

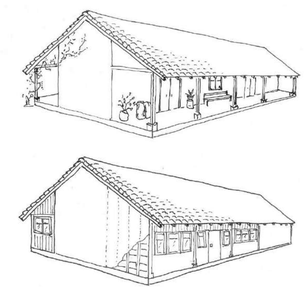


Metodología

Se documentó la vivienda vernácula, a través de un método cualitativo de enfoque etnográfico realizando observaciones participativas de campo en el objeto de estudio inmueble.
El proyecto parte con un conversatorio abierto a la comunidad y a continuación se recorrieron 15 sectores de la comuna, donde se identificaron 25 viviendas de interés arquitectónico, de las cuales 5 fueron seleccionadas como casos de estudio obedeciendo a los siguientes criterios:
a) Obra con mínima intervención
b) Evidencia de materiales vernáculos
c) Antigüedad y/o valor histórico
d) Casas del habitante común
e) Diversidad de funciones
Se elaboraron fichas de registro, fotografías y un levantamiento planimétrico (empezamiento, plantas y elevaciones) de cada caso.
Se realizaron entrevistas a conocedores de las técnicas y a familias propietarias de las casas, lo que permitió registrar la cultura constructiva local.

Resultados

El material recopilado es amplio abarca aspectos técnicos-constructivos y antropológicos. Luego de las etapas de análisis se obtuvieron los siguientes resultados:
1. Registro de contexto, que incluye información histórica, climática y demográfica de la comuna.
2. Fichas de cada caso estudiado, que incluye planimetría, programa, georreferenciación, contexto y forma, particularidades constructivas, programa y modo en que se habitaba a finales del s XIX y siglo XX.
Las viviendas estudiadas son:
-Casa Rubio Catalán. Antigüedad: 150 años
-Casa Cornejo Pérez. Antigüedad: 57 años.
-Casa Silva Silva. Antigüedad: 104 años.
-Casa Cornejo Rojas. Antigüedad: 185 años.
-Casa Gastón Lizana. Antigüedad: 170 años.
3. Caracterización de las técnicas constructivas, donde se puede observar que los 5 casos estudiados comparten el sistema constructivo de mampostería de adobe con pequeñas variaciones entre uno y otro; se componen de muros macizos con adobes de diferentes dimensiones, cimiento y sobrecimiento de piedras pegadas con barro, piso original de tierra, vigas de álamo a la vista labradas a mano y cubierta de tejas.
4.Caracterización de recintos, elementos y artefactos indispensables para la vida en el secano entre los que destacan: corredor, patio interior, parrón, galpón, molinos de viento, hornos de barro, cocina de cimiento, entre otros.
5.Registro escrito y audiovisual de las memorias de 5 conocedores de las técnicas de construcción tradicionales: Gabriel Núñez, Raúl Silva, Floriberto Huerta, Santiago Moreno y Héctor Castro.
6.Reflexiones en torno al habitar, donde se destaca el destino agrícola con el que se edificaron estas casas que disponen de grandes recintos para el acopio de alimento. Ellas se adaptan a la llegada de la modernidad, cerrando sus corredores con adobe en pandereta y/o madera para albergar habitaciones que responden a un nuevo estilo de vida.



Conclusiones

Esta investigación cierra un primer ciclo con la publicación del libro digital titulado "La casa del secano" y marca el inicio de un proceso educativo territorial donde la difusión del mismo y su material audiovisual sentaron un precedente de salvaguarda del patrimonio en la comuna.
En cuanto a lo técnico- constructivo concluimos que las viviendas respetan las formas ortogonales con plantas rectangulares, en L o en U que se organizan en torno a un patio interior. Si bien hay variaciones en el tamaño de los adobes, la altura de los cimientos y altura de muros, estas no alteran el comportamiento del sistema constructivo, por lo tanto, se corrobora que pertenecen a una misma tipología que es parte de la "cultura constructiva del valle central" la que se mantuvo vigente hasta mediados del s. XX en Marchigüe.
En cuanto a lo antropológico resalta el impacto del proyecto en los entrevistados que recibieron un reconocimiento público por ser guardianes del patrimonio cultural, ellos han sido valorados por las autoridades locales y su comunidad. Hay un logro en el plano de los afectos, la memoria y el autoestima; este es el corazón y el punto de partida para el éxito de cualquier iniciativa futura. Las familias colaboradoras se sienten orgullosas de sus casas y están atentas a algún tipo de ayuda para realizar mantenciones y restauraciones. Los cultores han comenzado a realizar pequeñas pero valiosas acciones educativas. Así concluimos que la documentación de arquitectura vernácula de una localidad es el paso inicial al rescate práctico que se puede aplicar tanto en procesos de escuela de oficios, restauraciones y en la gestación de obras nuevas con pertinencia local.

*Mapa de ruta_*

Accede al artículo

Accede al libro

ESTUDIO KURPA

La Casa del Secano

PANGEA

Ministerio de las Culturas, las Artes y el Patrimonio
Gobierno de Chile

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2-4 July 2024 Grenoble (FRANCE)

Safeguarding of the earthen architecture of the Aysen region, with a view to its conservation, rehabilitation and adaptation to current construction technologies

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CONSERVATION, REHABILITATION AND ADAPTATION OF HERITAGE

Summary

The region of Aysen, Chile, located in the South American-Patagonian continent, between 43°38' and 49°16' South Latitude, has a valuable tradition of earthen construction, which has been scarcely studied. In the first place, this architecture represents the wisdom assimilated and expressed by those who settled in the territory. Through manual and 3D recording, we have been able to identify in detail the qualities of the materiality and the current state of deterioration of the heritage buildibngs and design measures to safeguard, conserve, and protect them in the short and medium term.

Methodology

Constructions in adobe-wood and quincha (*n*, 22) were identified and selected on the southwestern shore of Lago General Carrera, commune of Chile Chico. Works carried out in the heritage buildings involved the measurement and projection of planimetry in plan, elevation, and sections, identification of the materiality, taking of interior and exterior photographs, and geo-referencing of their spatial location. In addition, a Trimble X7 3D laser scanner was used, a process which included three-dimensional imaging on-site for five buildings with detail adjusted to the millimeter of definition (Castillo et al. 2023). This made it possible to "take" the architectural structures to the laboratory to study and analyze the materials, among other things. At the same time and within the area where the buildings were located, a dendrochronological sampling was carried out at 30 cm from the base of the main trunk of the tree (*n*, 140; exotic species such as poplars, willows, and fruit trees, and native species), with the objective of making a comparative study between the year of establishment or planting of these trees by the settlers and the period of construction of the buildings (Castillo y Pérez 2019).

Oral, semi-structured interviews were conducted in order to capture life testimonies of those people who were directly or indirectly related to each of the buildings under study and to learn the exact period or year of construction, which allowed us to obtain more detailed knowledge of personal experiences of the interviewees about the events that occurred around each of these buildings and their surroundings (social and economic relations at the local level).

Results

The adobe and quincha constructions in the Aysén region are characterized as a type of self-built architecture, with noble materials and produced in the same area where the buildings are located. The materials used to make the adobes are clay, coirón (a type of straw) and wheat and/or oat stubble, all of which are mixed with horse manure (Castillo y Pérez 2020). Among the wood commonly used for doors, windows, roof trusses, floors, beams, sills and shingles, wood from species of the *Nothofagus* genus stands out (Figure 1 and Table 1). Walls are covered with mud mortar and others coated with a second layer of lime, which was produced in a kiln near Puerto Guadal, a town in the commune of Chile Chico (Castillo y Pérez 2020).

Regarding the year of arrival of the settlers/owners of the buildings under study on the southwestern shore of Lago General Carrera, the results of the dendrochronological analysis allowed us to determine that the earliest settlement corresponds to the areas of Río Avilés (1910s), followed by Fachinal (1920s), Mallín Grande (mid-1925), Puerto Guadal (late1920s and early 1930s) and Valle Leones (1930s) (Figure 2). It is important to emphasize that at each arrival site, the settlers and their families established or planted different trees that served different functions, such as ornaments, windbreaks, fruit trees, and orchards, to protect water wells and watering places in general. They were planted in the same year of arrival or during the first two years and in some cases they were planted earlier (by advanced settlers).

Current state of deterioration

The buildings under study have different degrees of deterioration, mainly in their original construction materials, such as adobe and wood (Table 1). The main damage observed include: window breakage; breakage of interior overlapping boards and ceiling; deterioration of the interior floor; crumbling and cracks on the adobe walls; deterioration of the wood of the window frames, doors, and roof trusses; signs of rotting and cracks in beams; rotting of the roofing strips; and a high extensive damage by fungi, insects, mosses, and the effects of weathering on the wooden roof tiles (Gómez et al. 2020).

Challenges and projections

Due to the high degree of deterioration of the buildings under study, it is urgent to raise awareness of the importance of these vernacular architectural vestiges as vessels of cultural identity and local history linked to the settlements since the early twentieth century. The present study and its results will be an important input to outline a work plan between different groups that will allow, in a short term, to visualize this self-built architectural heritage in order to protect and conserve it. On the other hand, the incorporation of 3D technology in the records makes it possible to study the buildings and create data on: 360° panoramic images, a 360° image tour, a cloud of filtered points of each building, with an accuracy of 2mm between each point for modeling, a 3D video tour of the cloud of points of the building and sections of different areas for the reconstruction of its planimetry in plan and elevation.

The research on earthen construction techniques with different manual and digital recording tools is a valuable input for the understanding of the architectural technique for this particular territory and, at the same time, it is fundamental for us to begin to look for and propose conservation and restoration proposals for these buildings, in both the short and medium term, which should consider a joint work with the community in which they are inserted, with the governmental institutions to which they are associated, and with the academic researchers to which they are linked.

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Figure 1. Adobe and quincha architecture. Details of structure, materiality and orthophoto (Faro scene).

Figure 2. Analysis of simple linear regression between basal diameter (at 30 cm) and the estimated age (years) of the trees sampled at the sites of the earthen architecture (n, 140).

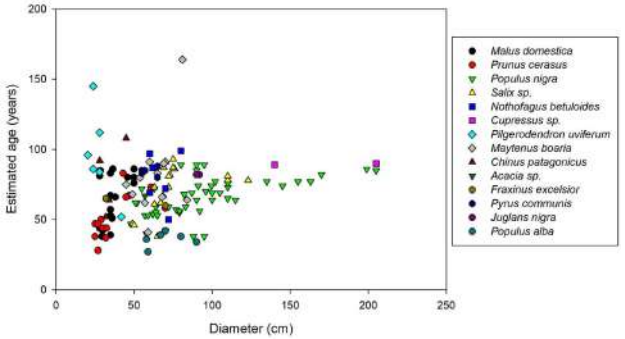

Table 1. Current status of earthen architecture recorded with Trimble X7 laser scanner (n, 5), commune of Chile Chico, Aysen region, Chile.

Type of building - Family	Period or year of construction (orality)	Materiality and tree species used	Surface area (m²)	Current state of conservation	Need for intervention (low, medium, or high)*	Estimated year of establishment of trees
Adobe shed - San Martin Family	1960	Adobe, wood, and stone. *Nothofagus pumilio* *Nothofagus antartica* *Nothofagus betuloides*	62	This building is in use and shows an advanced state of deterioration of its materiality.	high	1961*, 1963*, 1965, 1967, 1967, 1980, 1963*, 1979
Adobe house - Mancilla Family	1940	Adobe, wood, and stone. *N. pumilio* *N. betuloides*	69	This building is in an advanced stage of crumbling.	Unrecoverable	1932*, 1935*, 1935*, 1937*, 1934*, 1934*, 1935*, 1934*, 1939*, 1947*, 1947*, 1953, 1958, 1959
Adobe house – Ulloa Family	1950	Adobe, wood, and stone. *N. pumilio*	73	This building is in disuse and shows an advanced state of deterioration of its materiality.	high	1973, 1973, 1974, 1982, 1982, 1981, 1981
Quincha house – Delgado Family	1950	Wood, mud, and stone. *N. pumilio* *N. betuloides*	45	This building is in disuse and shows an advanced deterioration of its materials.	high	-
Adobe house – Burgos Family	1950	Adobe, wood, and stone. *N. pumilio* *N. betuloides* *N. antartica*	35	This building is in disuse and shows an advanced deterioration of its materials.	high	-

*This refers to the process of repairing and replacing damaged materials in the short term. This stage should consider the production of materials according to the local traditional crafts in adobe, baked bricks, quincha, pyrena and masonry, and wood craftsmanship such as shingles, wood carved with axe and sawn.

*Trees whose annual growth ring dating data is consistent with data from the period of arrival, establishment, and construction of vernacular architecture as revealed through oral information (interview).

CMA; Austral Memory Organization; CIEP, Center for Research in Patagonian Ecosystems; PUCV, Pontifical Catholic University of Valparaiso.

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2-4 July 2024 Grenoble (FRANCE)

Construction characteristics and Its Inheritance and Development of earthen houses in Liling, Hunan Province

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THEME 1 - HERITAGE CONSERVATION, REHABILITATION AND ADAPTATION

Fig. 1. Hunan Province and Liling kiln location
Fig. 2. The Liling kiln site
Fig. 3. Layout of workshop and farmhouse
Fig. 4. Roof and wall
Fig. 5. Wall deformation chromatography and orthophotogram
Fig. 6. Village landscape

Summary

The study takes the residence in Liling Kiln site as research subject, from the two impact perspectives of humanistic environment and natural geographic environment, extracts the architectural style and characteristics of Liling traditional residence. Based on the research results, this paper summarizes the current conservation status of the local earth dwellings and the problems existing in their development. In response to these issues, strategies for the inheritance and development of traditional dwellings in Liling area are proposed.

introduction

Liling Kiln site is located in Liling City, Hunan Province (Fig. 1), the site is distributed in Weishan town, Fenglin town, Zuoquan Town, Sunjiawan town, and other towns and villages, with a total distri-bution area of 129 square kilometers. It is a rare large-scale site with highly rich cultural connota-tions in southern China. The core area, Weishan Village, where Liling Kiln is located, was declared as a «Chinese Historical and Cultural Famous Vil-lage» and «Chinese Traditional Village» in 2019. Due to the advantages of convenient material sourcing, simple construction techniques, and low cost, earth materials have been highly popular in Liling, where earth-built structures are widely found. Since the 1950s, they have mostly been used as residences, school buildings, village shops, and other purposes, surviving until the present day (Fig. 2). The ancient buildings in the village have become precarious due to long-term uninhabited, disrepair, lack of management, and the erosion of natural wind and rain.

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methodology

1. To understand the geographical environment and landform of Weishan village through historical literature retrieval and field investigation, and to understand the influence of climate, vegetation and hydrology on the architectural site in Liling Yao area.

2. Understand the construction technology and traditional craft of local buildings through interviews with villagers.

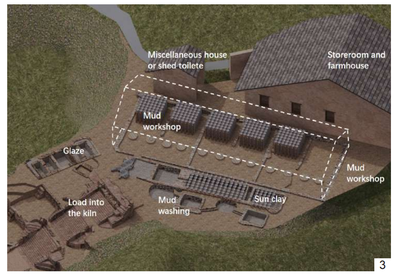
3. Master the architectural style and characteristics of traditional buildings in Liling Yao area of Weishan Village through site investigation, data collection and statistical analysis.

4. Select representative buildings and use 3D laser scanner and other related equipment to detect the existing conditions of rammed earth buildings.

Results

1. The Relationship between Environment and Earth-built Houses: Natural Conditions: Weishan Village has a unique geographical environment, which is rich in high-quality porcelain clay mines and limestone mines. The human environment: Liling is located in the eastern mountainous region of Hunan Province, bordering Jiangxi Province to the east and 260 kilometers away from Jingdezhen, the capital of porcelain in China. It attracted a large number of talents.

2. Architectural style and characteristics: The houses can be broadly classified into three categories based on their specifications and quality :workers' houses, family temples and workshops (Fig. 3). These houses typically adopt a



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three-bay layout, with the central room serving as the main hall, flanked by side rooms and bedrooms on both sides. Kiln bricks are usually used as the ground, and clay, stone, and lime are used as rammed earth walls (Fig. 4).

3. The Current Status and Developmental Issues: After investigation, it can be concluded that most earth houses have issues such as wall tilting, erosion, cracking, and roof damage (Fig. 5). The stagnation of the industry and the discontinuity of craftsmen have brought huge challenges to the dissemination and inheritance of traditional residential construction skills and regional culture.

conclusion

The ruins of Liling Kiln and the earth buildings of traditional villages have historical and cultural value.

In order to protect these important values, it is essential to strengthen the protection and display of traditional houses, as well as the training and inheritance of traditional architectural techniques. Preserving the cultural relics and historical sites related to the kiln, this serves as a feasible approach to preserving traditional culture.

To adapt to contemporary development, modern residences can improve living conditions and raise living standards while drawing inspiration from the green and ecological construction techniques of traditional residences.

Meanwhile, by protecting and displaying cultural heritage, the cultural resources of rural areas can be integrated with the tourism industry to enhance the value and charm of rural areas (Fig. 6). Inspiring more talents to return to rural areas, learn traditional skills, inherit culture, and inspire more people's enthusiasm for rural construction.

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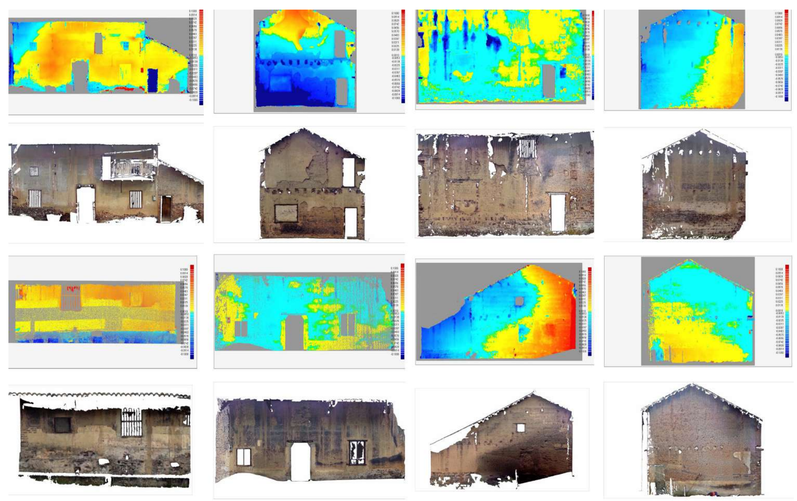
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2-4 July 2024 Grenoble (FRANCE)

La conservation des villes en terre en Amérique Latine : perspectives de gouvernance d'un patrimoine fragile

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THÈME 1. CONSERVATION, RÉHABILITATION ET ADAPTATION DU PATRIMOINE

Introduction

Les caractéristiques des centres historiques de l'Amérique latine sont strictement liées à leur nature de ville de fondation. On peut constater que l'urbanisme colonial espagnol a donné lieu à des caractères communs et comparables entre toutes les grandes villes du continent : grille orthogonale en plan, centrée sur une *Plaza Mayor* sur laquelle donnent les lieux du pouvoir [Sartor 1980]. Mais l'une des caractéristiques les plus distinctives est l'utilisation de techniques de construction en terre dans différents bâtiments des centres historiques. Ces pratiques sont des exemples de mélanges de techniques de construction indigènes, des cultures précolombiennes existantes dans la région et de la culture technique et architecturale espagnole.
Quoique ces techniques aient résisté jusqu'à aujourd'hui, c'est précisément au cours de ces dernières décennies qu'elles sont soumises à des vulnérabilités et à des risques croissants. Même si sa géographie place l'Amérique latine dans un contexte sismique et volcanique de grande importance, on peut vérifier que les facteurs de risque plus diffusés sont souvent de nature anthropique, ou, pour mieux dire, sont l'enchevêtrement des facteurs du risque naturel et le manque de gestion et gouvernance appropriée [UNESCO 2014]. A travers de l'analyse d'études de cas, le but de l'article est l'analyse et l'indication des lignes directrices qui peuvent montrer des nouvelles perspectives de conservation, avec l'intégration de la gestion du risque et dans la conservation préventive, souvent avec une grande contribution et collaboration avec les communautés locales.

Méthodologie et lignes d'investigation

La méthodologie est divisée par trois lignes d'investigation. La première partie est une analyse bibliographique et scientifique sur l'individuation, l'évaluation et la gestion des risques dans les villes patrimonialisées d'Amérique, en incluant aussi des événements catastrophiques que peuvent être vus comme moment fondamental pour le changement de perception sur le bâti en terre. La deuxième est une analyse ponctuelle des villes déclarées comme « en Danger » par l'UNESCO, évaluant les risques aux lesquels elles sont soumises. Enfin, la troisième partie est la recherche des études de cas vertueuses dans la même zone géographique, pour tirer des leçons au niveau des politiques de gestion.
Tout d'abord, l'Amérique latine se situe dans un contexte de risques naturel de grande importance. Les phénomènes sismiques, volcaniques et d'inondations (pour citer seulement quelques-uns des facteurs présents) qui se sont produits au cours des siècles ont maintenant un autre impact : si auparavant les villes, après ces catastrophes, étaient reconstruites avec les mêmes techniques et typologies, il est maintenant possible de mettre en évidence une accélération des phénomènes d'abandon et de substitution. Par exemple, après le tremblement de terre de Guatemala en 1976, une grande partie des bâtiments du centre historique ont été reconstruits avec des types de bâtiments contemporains, en béton armé, peu adaptés au contexte urbain [Bates, Killian 1977]. De même façon, après les inondations de la ville de Coro au Venezuela, des parties du tissu urbain historique sont abandonnées [UNESCO 2008]. Il est également à noter que la vulnérabilité de ce patrimoine entraîne non seulement une perte physique de l'artefact, mais aussi une perte du patrimoine immatériel de traditions, de techniques et de folklores.
Le risque majeur est donc présumable comme le risque de non-reconnaissance des architectures historiques en terre comme patrimoine, et, plus en général, le manque d'un système de gouvernance. Ces deux facteurs mettent en danger et oublient les centres historiques d'Amérique Latine et le bagage de tradition qu'ils portent avec eux. C'est un risque d'oubli non dû à la perte de fonction ou à la perte de signification dans un contexte socioculturel mais un oubli dû à la perception de ce patrimoine comme jetable et substituable.

Villes en danger

Les villes UNESCO de l'Amérique hispanophone peuvent offrir un premier regard de ces facteurs de risque : par exemple, l'UNESCO reconnaît en cette zone géographique vingt-trois villes historiques en terre comme Patrimoine Mondial de l'Humanité. En ces vingt-trois cas, il y a deux villes qui sont insérées dans la liste du Patrimoine Mondial en Danger : Coro et La Vela, en Venezuela et Potosi, en Bolivie [Joffroy 2012]. Les deux cas sont comparables parce que tous les deux ont été déclarés « en Danger » entre la moitié des années '90 et le 2005, et ils sont dans de contextes social, culturel et géopolitique similaires. Potosi a été inclus dans la liste « en Danger » après des effondrements du sol causés par les activités minéralières autour de la ville ; Coro et La Vela ont été inclus après des inondations et des événements atmosphériques en les années 2003 et 2004 [UNESCO 2008].
Un instrument qu'on peut utiliser pour évaluer les facteurs des risques est la grande quantité de documents que l'UNESCO met à disposition. Les documents sont classifiés en catégories : les Reports de Mission ICOMOS, les *State Party Report* et, enfin, les *State of Conservation Report*. Si on analyse les facteurs de risque les plus diffusés, et donc plus rapportés par les missions UNESCO, se manifeste ce que c'était une hypothèse dans les paragraphes précédents. Pour la ville de Potosi, le facteur de risque plus diffusé est un manque de gestion, soit-elle un plan de gestion approprié ou des activités inadéquates, et d'un cadre législatif de conservation. Parallèlement, à Coro les risques d'inondation sont attribués à un même manque d'un plan de gestion préventive contre ces événements [UNESCO 2014]. Tout cela se traduit par peu de sauvegarde et d'absence de politique de protection, mettant ainsi l'accent sur la nécessité de nouvelles lignes directrices pour la sauvegarde d'un patrimoine fragile.

Des gouvernances vertueuses

Deux études de cas de la même zone géographique seront analysées pour mettre l'accent d'une part sur d'autres problématiques, et d'autre part sur des politiques de protection partagée et participative possibles, à travers l'implication des communautés locales.
Le premier cas est Cuenca, en Équateur. Son centre historique, qui grâce à des politiques de protection a obtenu la reconnaissance de l'UNESCO en 1999, est en fait soumis à de nouveaux défis et risques d'origine anthropique. La nouvelle lumière posée par la reconnaissance comme patrimoine mondial, unie à la qualité et au coût de la vie en Equateur, n'a fait que de plus en plus d'étrangers, souvent nord-américains, choisissant la ville comme lieu de vacances et de retraite. Cela a donc déclenché des phénomènes de gentrification qui, s'ils ont permis une plus grande conservation des artefacts, ont également évincé la population locale de son propre centre historique. C'est à ce moment-là que le gouvernement national et municipal a commencé des pratiques de réinsertion et encouragé des interventions pour ramener la population locale dans le centre historique [Abad Rosas 2013]. En cette nouvelle gouvernance, la mairie de Cuenca a bien collaboré avec l'Université locale et la chaire UNESCO PRECOM3OS, sur la thématique de la conservation préventive, qui ont inclus la population locale comme agent actif dans la conservation du tissu urbain historique en terre [Cardoso Martinez 2015].
Le deuxième cas, en revanche, est toujours celui de Coro et La Vela, au Venezuela. Celui-ci est-il également reconnu comme bien de l'UNESCO au Venezuela en 1993, et il a su intégrer différentes politiques d'inclusion sociale qui sont pertinentes pour la conservation du patrimoine urbain parce qu'il s'agit d'une initiative populaire. Les citoyens de Coro se sont organisés de manière autonome en coopérative, comme l'*Asociación Autogestión de Vivienda* (ASOAVI), Coopérative intergénérationnelle pour transmettre des pratiques constructives en terre et pour la réhabilitation des bâtiments du centre historique de Coro. A la suite de ses activités, il y a eu un regain d'intérêt pour ces pratiques, avec la fondation de l'*Escuela del Barro*, école autogérée pour l'enseignement des techniques de construction en adobe en collaboration avec plusieurs universités de la région centraméricaine (UNAM) [Guerrero Baca 2013].

Une collaboration communautaire

Le contexte latino-américain peut être observé pour mieux comprendre des nouveaux paradigmes de gestion du patrimoine historique, que souvent sont aussi des paradigmes de gestion collaborative. Ils ne sont pas des processus d'inclusion des communautés locales comme « clients » ou pour « collecter » leurs désirs, mais ils sont des pactes de collaboration et de responsabilisation de quelles communautés de citoyens qui insistent sur l'espace patrimonial, et que peuvent travailler conjointement aux acteurs publics pour la conservation du patrimoine [Sokka 2021]. Si le risque auquel on veut répondre est la non-reconnaissance des architectures en terre comme patrimoine (tant matériel qu'immatériel, avec tout le bagage de pratiques traditionnelles), il sera alors nécessaire de définir des lignes directrices qui permettent le renversement du récit et de la perception de ce patrimoine comme « mineur ».
Il est donc nécessaire d'impliquer activement les communautés locales avec des pratiques ascendantes et participatives (en synergie avec les approches traditionnelles *top-down*) également pour les spécificités du matériel terre, qui a besoin d'entretiens et de soins constants, qui peuvent être menées par les habitants eux-mêmes comme dans le passé, à travers un processus de sensibilisation et de responsabilisation.

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2. Dommages du seisme du février 1976 en Guatemala
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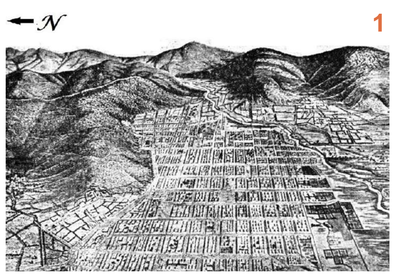
4. Une quartier historique de Cuenca
5. Affiche d'un atelier participatif sur la terre crue tenu à Cuenca
6. Mission de photogrammetrie et de reportage des dommages tenue à Coro



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2-4 July 2024 Grenoble (FRANCE)

From Theory to Practice

Ana Michel, Universidad Autónoma de Baja, California, México ; Eman A. Selim, Heba A. Moawad, Mahmoud S. Mostafa, Faculty of Archaeology Ain Shams University, Egypt;
Shadia Abdrabo, National Corporation for antiquities and museums, Sudan;
TRAINING COURSE , EARTH CONSTRUCTION TECHNIQUES

Summary

The seven-week training course from CRAterre was focus on the Conservation and management of earthen archaeological heritage, that is why an archeologist from Sudan, and three from Egypt were taking it, in order to acquire the knowledge they can share in their original countries with their co-workers in the sites; an architect from Mexico also join the group but focus in the leaning process for techniques and soil construction systems. The group diversity makes an active course between archaeology, architecture and conservation.

The course was at CRAterre's installations at Grenoble, taught by more than 50 trainers.

Targeting different perspectives since the knowledge of the system and characterizations of soils through several sessions of soil analyses, diagnosis and archaeological buildings conservation techniques, site visits and excursions in addition to discussing several case studies through the training seminars.

Site visits

The way to obtein information of our past, is through the discovery and learning of the architecture through the archeological sites, those are the ones that tell history of soil construction techniques that had lost in some moments.

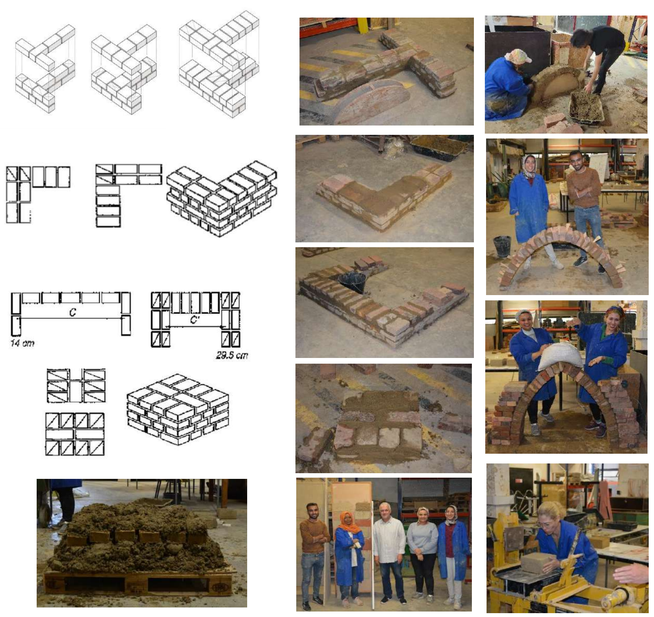
Testing soil analyses in site & lab

In the site is important to get information about characteristics of soils, the pictures above show different tests that can be applied.

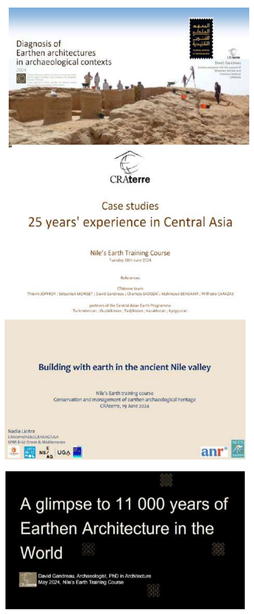
Construction

The process to build with materials from earth, are steps to be considered, some of those are mechanical tests that give us the quality of materials. Others are details that we need to solve to make them function.

Thought this process was needed to create different pieces to undesrtand the behavior of the ingredients; also these ingredients can be use for plaster, and mortar.



Seminars



Conclusion

Outcome of the Nile's Earth Training 2024 enhance the opportunity to train students and co-workers in the field, like archaeologists or architects by sharing knowledge and experiences acquired from CRAterre's team. Providing strong lessons about building and conservation techniques from soils.

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De la escala del sitio y del objeto arquitectónico al detalle constructivo en tierra
El método y los principios teóricos para la solución de la tectónica

MAURICIO GANDUGLIA – UNIVERSIDAD LUSÍADA DE ANGOLA

TEMA 3

1. Resumen:

Este trabajo presenta resultados de la metodología de las disciplinas de Construcciones y Arquitectura del segundo año y de Construcciones, del tercer año del curso de Arquitectura.

En su comienzo la metodología del curso era integrar , los resultados de las disciplinas de Arquitectura y Construcciones en el trabajo final de cada año .

Además de integrar los materiales naturales y las técnicas constructivas con tierra, el objetivo de esta metodología es trascender el resultado de la solución técnico-constructiva específica para encontrar respuestas y argumentos proprios de la tectónica de las ideas, conectando la practica constructiva con la teoría de la arquitectura, desde la composición y el análisis de contexto, hasta el análisis arquitectónico y antropométrico.

2. Introducción:

Teniendo en cuenta el programa de estudios, la metodología toma como referencia:

- La teoría de la arquitectura (según el programa de cada año) considerando la materialidad (técnicas y sistemas constructivos) y, la teoría (historia, estilos) y la espacialidad arquitectónica y urbana.
- Las obras de referencia que son parte del programa, y evidencian la aplicación, tanto de los principios teóricos como de la materialidad investigada.
- EL Dibujo artístico y técnico (a mano alzada y digital), según el programa de estudios.

El método se estructura con todos los elementos de la investigación científica, y considera fundamental e indisociable a la relación texto-dibujo.

3. Método:

Considerando que los estudiantes están en el segundo año, apenas iniciando en la teoría y los principios de diseño, el método toma estas referencias y define algunas reglas:

- EL DIBUJO: Los diseños técnicos evidencian los resultados de la propuesta, y las ideas se explican con esquemas (esquicios) complementarios.
- EL FORMATO: La teoría se resuelve en fichas de Formato A4 y el dossier de Proyecto en A3.
- EL TEXTO: Es fundamental comunicar las ideas. Sustituir una memoria descriptiva por un texto explicativo es fundamental. El dibujo técnico y los esquicios describen la propuesta, pero es necesario un texto explicativo integrador para dar secuencia a las ideas y criterios que llevaron a desarrollar la propuesta técnico-constructiva.

4. Resultado:

Si el fin es resolver la solución constructiva, la propuesta interesa si habla de tectónica, desde la espacialidad y la composición de la forma, al material y su resistencia. Es la forma del objeto arquitectónico según su materialidad.

Por este motivo, la propuesta tectónica se desarrolla y se explica en 5 escalas, con una condición: solo se puede hablar de lo que es posible visualizar en cada una de ellas:

La escala 1:500 o 1:250 permite visualizar la propuesta integral. Además de ver la implantación, es la oportunidad para presentar las primeras ideas de las formas del lugar y los criterios compositivos que definen la forma resultante (principios organizadores: retícula, geometría, etc.). Es la escala compositiva

La escala 1:100 presenta la solución funcional del objeto arquitectónico (circulaciones, zonificación, modulo estructural, modulo espacial, etc.) en el dibujo técnico. Es la escala arquitectónica

La escala 1:50 permite visualizar como se utilizan los materiales de cada elemento constructivos en la tipología arquitectónica, y visualizar la propuesta de la fachada. Incluye temas de habitabilidad y confort, como iluminación natural, ventilación y sombras. Es la escala de estética y confort

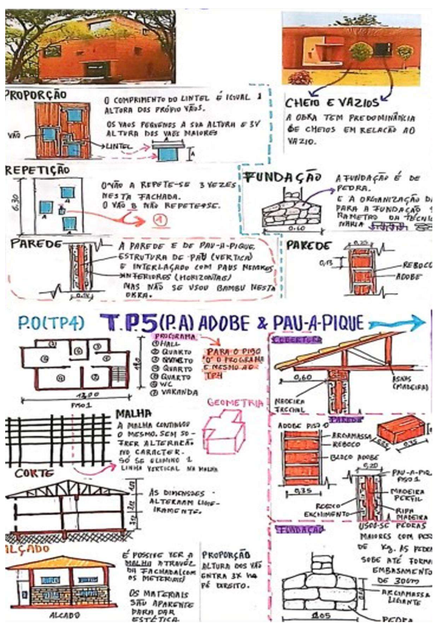
La escala 1:20 es la escala intermedia entre la tipología y el detalle constructivo. La llamamos escala del sector-espacio y permite evidenciar la materialidad de todos los elementos constructivos para resolver un espacio habitable, (planta y corte). En este momento se hacen los estudios antropométricos para resolver el aprovechamiento de los espacios. Es la escala tecnológica.

En la escala 1:5, el detalle constructivo evidencia los materiales utilizados que permiten resolver la propuesta arquitectónica, teniendo en cuenta sus propiedades físicas (forma, función, densidad y resistencia) de la materialidad. Es la escala de la materialidad.

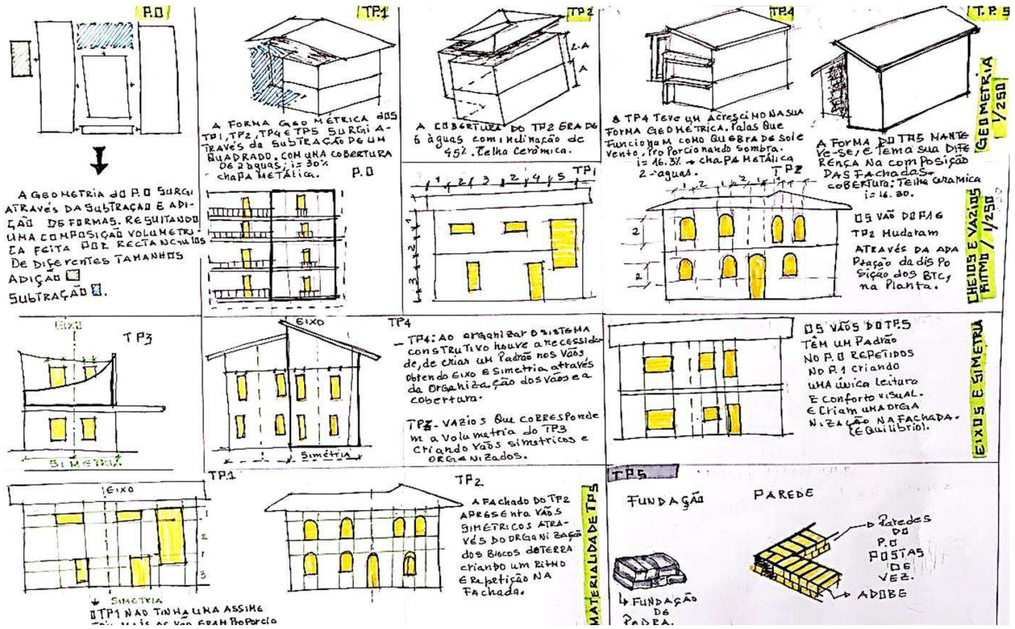
5. Conclusion:

* El método da la posibilidad de que cada estudiante construya un argumento con todas sus componentes respetando sus preferencias.. Los estudiantes se sienten más confiados y seguros cuando eligen la forma de abordar el tema: objetivo (racional) o subjetivo (emocional, gustos)
* El ejercicio de dibujar el texto evidenció la dificultad de explicar las ideas de manera concisa.
* El tema fundamental es la materialidad. Los estudiantes comprenden que cada material (o técnica) tiene sus reglas especificas que definen la forma del objeto arquitectónico. Encontrar el sistema de medidas de la idea arquitectónica es el desafío.

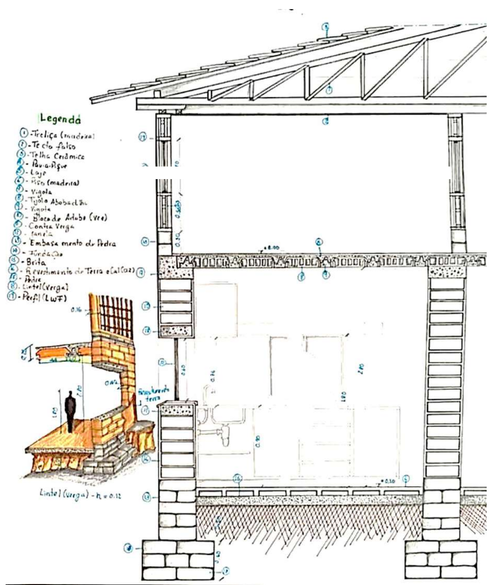
Escala 1:250 Análisis de Obra de Referencia (AOR) Estudiante: Pedro Zankatu / 2022-23



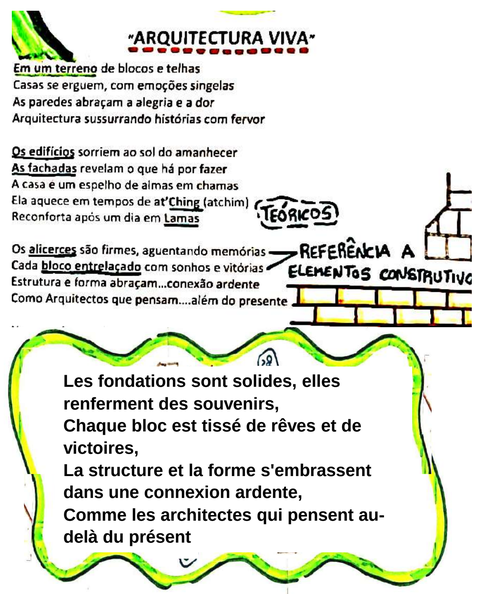
Escala 1:100, EL objeto arquitectónico (la vivienda). Estudio de la evolución de las paredes y las puertas-ventanas en fachadas. Estudiante: Natalia Hama / 2023-24



Escala 1:20, la materialidad desde el tejado a las fundaciones. (secuencia de cargas) Estudiante: Kelaine Miguel / 2023-24



Arquitectura, razón y emoción. La materialidad, el arte y la poesía. Estudiante: Hermen Santos / 2022-23



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2-4 July 2024 Grenoble (FRANCE)

Use of scale model in the teaching-learning process of earth architecture

YOLANDA G. ARANDA JIMENEZ - Autonomous University of Tamaulipas, UAT, in the Faculty of Architecture, Design and Urbanism, FADU.

THEME 3 TRAINING PROGRAMS, PROFESSIONAL CERTIFICATION

Summary

The teaching process of construction with raw earth, within Universities or Higher Education Centers, increasingly requires greater planning and availability of resources, since its teaching implies a duality of theory and workshop at the same time. Currently the use of scale to create models and maquettes is fundamental, such tools have been used in this process for the appreciation of space and design. However, in earthen construction, they are a simulator of how to carry out construction systems and how to work with earth or clay.

Simultaneously, in all higher education institutions there is a worldwide trend to comply with the UN SDGs (Sustainable Development Goals), since new generations will have the difficult task of managing non-renewable resources (energy, water, among others), but also, that the actions undertaken by anthropogenic development tend to care for the planet. That is why teaching must be comprehensive, not only the theory of construction systems, but also create a true awareness of sustainability, and that anthropogenic actions should have low environmental impact and apply reuse. Within the UNESCO Chair, the teaching and preservation of construction with raw earth must be consistent, in terms of resource management, optimization of times and materials management; in addition to taking care of quality teaching.

This process could be categorized into several levels which will have different objectives depending on the audience to which it is directed and according to the ages of the recipient. For example: workshops for children, workshops aimed at basic or intermediate level students, undergraduate students, postgraduate students, professionals who intend to specialize in heritage conservation. The objectives can vary from awareness and introductory knowledge of the earth as a material to the more specialized content.

Introduction

The UAT- FADU, since 2012 has had the distinction of the UNESCO Chair for earthen architecture, construction cultures and sustainable development. The teaching of the Earth Construction Chair needed to adapt to today's demands and after the pandemic, other pedagogical ways of teaching and giving workshops were generated.

Background: The teaching of said Chair to the students of the architecture program was given exclusively on Saturdays and only as a workshop where some earth construction systems were taught with a minimum of theoretical support and at a 1:1 scale, this led to a pedagogical rethinking in which future architects should assimilate knowledge first by reasoning about the importance of knowing other forms of sustainable construction, learning how to minimize the carbon footprint and be more responsible in caring for our planet.

Methodology

The objective of this work is to contrast the present methodology used with the results of the previous one in teaching the Earthen Architecture Chair, as well as the specific objectives to be achieved in the workshops through use of the scale model.

For this purpose, 2 groups were formed. The first only took the class one day a week where they also worked on a 1:1 scale model, with a minimum of theoretical support. The second group received the class 3 times per week, with theoretical explanation plus workshop and the work was done on 1:20 scale models.

The problems that were detected with the previous methodology were: a) Little theoretical support that would allow the appropriation of knowledge and a deep understanding that would allow reasoning about
what building with earth entails; b) Management as a workshop that was taught only once a week, there was no continuity and the scarcity of resources occurred constantly, since they were done on a 1:1 scale. c) The evaluations were based on practices and there was no exam.

The scale model, since then, has demonstrated its effectiveness as a pedagogical system (Carazo L., Galvan D. 2014 in Rodriguez M and Garcia G 2022).

Results

Regarding the workshops

For the undergraduate degree, it was observed that the appropriate methodology was not followed, and they only got to work without prior analysis support.

In the same way, in the workshops given both for children and for trainers and professionals, only 2 techniques were shown, which were CEB (Compressed Earth Blocks) and daubed earth. When researching, we arrived at the Teaching Guide for children's activities to raise awareness towards earthen architecture (Mileto, Vegas et al 2017) and based on this guide, which respects the cultural values of earthen architecture as well as divides the teaching into several stages according to age, these workshops began to be developed.

The undergraduate students of the FADU performance and appropriation of knowledge was observed in up to 85% against those students who received theoretical support and who also made a model. Those students who only took the workshop on a 1:1 scale only remembered the fatigue of making 100 CEB, or daubed earth chart, but not the general context of all the techniques. In other universities , such as the Universidad Mayor de San Andrés or the University of Chile, this methodology of using the smaller scale model as a tool is already being implemented for the appropriation of learning.

At the children's workshops: The little ones appropriated the knowledge, even making references to their grandmother's house, the ranch house, etc. Also mentioning that they wanted to be architects and take care of the planet. In the workshops for trainers and professionals: It was mentioned that the knowledge taught was totally new and they found its application within their profession, (architects and engineers) in the conservation and restoration of buildings, being aware that there is a whole universe to study and continue training.

Conclusions

The use of scale as a tool for appropriation of knowledge translated into models turns out to be one of the best methodologies for the teaching-learning process of earthen architecture. The advantages of doing it on a smaller scale are saving on material, ensuring that the Chair has continuity and not doing it just one day a week, which would imply working on a 1:1 scale.

The results for the first group showed that they do not remember the different construction systems, they are not very clear about the classification; while the students who received the class 3 times a week were very clear about the earthen construction techniques and the general panorama of this sustainable construction.

It was also observed that they were more willing to work, and camaraderie was more encouraged, as is generated in a 1:1 scale construction.

It was also verified that the same problems when making a 1:20 scale model occur in the 1:1 scale workshops, such as cracking in the walls, low adhesion with the earth mortar, etc. It is worth mentioning that the fiber used is also properly cut to scale according to the technique being carried out.

Another advantage is that the student can take his scale model and give greater dissemination to construction with earth, finding themselves also qualified to participate in Architecture Congresses with earth.

The new generations will have the responsibility of looking for more sustainable ways to build and with low environmental impact, it is up to educators to show alternatives that contribute to caring for the planet and earthen architecture is emerging as the best choice for the construction industry to achieve that goal.

Field and laboratory tests

Carazas Test

Daubed earth model (Bajareque)

Adobe model

Rammed earth and poured earth model

Earth workshop for children and teachers

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2-4 July 2024
Grenoble (FRANCE)

Architectural teaching through constructing with earth

MARIA MANDALAKI - SCHOOL OF ARCHITECTURE - TECHNICAL UNIVERSITY OF CRETE - BIOCLIMATIC AND EARTHEN DESIGN LAB

TRAINING

Summary

At the School of Architecture of the Technical University of Crete, a studio of "Special Structures with Natural Materials" is implemented. The aim of the studio is the realization of earthen constructions in 1/1 scale. Students are asked to develop a small structure whose function will be strongly connected with the basic construction material used. Basic functional and environmental properties of the earth as a building material are analyzed and demonstrated to the students concerning the type of soil used. Additionally, the tactile properties and sensation of the earthen materials are promoted. The intuitive understanding of the properties of this material aims to a more competent design of the constructions. Choosing soil as a basic construction material and with the anguish of the 1 to 1 scale realization of our constructions, we have the opportunity to look back to the basic process of architectural realization, to experience its group and collaborative nature, to think of ways of construction with the available tools and machines of the school's laboratories and we have the joy, the toil and the experience of manual working. Questions that arise: is there an impact on our architectural thinking through the process of building with earth, is soil a suitable material for education in architecture, what further concepts and elements are explored through the investigation of the detailing of the constructions with natural materials.

Introduction

There are two main benefits of building on 1/1 scale with natural materials for the architect as a professional and as a human being: the acquisition of technical - construction knowledge and its connection with the concept of «Building - Dwelling -Thinking". During the previous two summer semesters, the special compulsory studio «Special constructions with natural materials» took place at the School of Architecture of the Technical University of Crete. The studio is open to students of the 8th semester and above. The main objective of the studio is the conception and implementation of small-scale constructions using raw earth within the framework of the principles «firmitas, utilitas, venustas».

Methodology

The first semester the question posed to the students is the conception of outdoor structures from unstabilized raw earth, that will be implemented by a repeating structural element, a plinth with its variations. The next semester, research was undertaken for the implementation of mainly indoor constructions where their use and operation will be inextricably linked to this material. The aim of Constructions is the absolute correlation of their function with the properties of raw earth as a structural element. The main concern of their proposal for the appropriate construction arises from the following question: «why earth is the most suitable material for the operation of my construction?». All projects are a reuslt of group work and the process followed is based on the principles of research, analysis, conception, synthesis, experimentation, working models, organization of a series of construction work. Each project questions three different concepts: how to implement the traditional techniques of construction in contemporary design, what can be created with only one repeating unit and what is the environmental footprint of a structure while proposing a final product following their familiar way of dealing with architectural projects, from the sketch to the final product. Some examples of their work is presented in this poster.

Results

Reinventing the traditional techniques: Within the framework of the creation of a repeating unit and taking into account the sound absorbing property of the material with the use of parametric design, the team designs a plinth with such a geometry that it has the maximum exposed surface so that it can be maximally sound absorbing(FIG.3). Research of archetypal forms: Musical instruments: sound properties of soil. Starting from the Minoan rattle and aiming at the direct connection of the traditional ceremonies of Earth and sound, the team research the sound effects resulting from the construction of closed percussion instruments of different geometries and different mixtures. They produce sounds of multiple qualities. Dome - ways of construction: a group of students dealt with the way of dome construction with different techniques: with the use of mold, with the use of scaffolding, without the use of scaffolding and proceeded to the construction of two types of domes with two of the above ways. The repeating unit: the plinth – the adobe: In order to create a container for composting through the repetition of a similar structural element, the group of students redesigns the classical plinth. They propose a «Lego» type, plinth, in plot. They build their pots, which may be repeated in series according to the needs of the construction (FIG.6). What can I create with the same repeating unit? How small repeating units make a whole. This whole is repeated to create a path. Through these questions the group of students creates an earthen lamp for the natural paths (E4 or different category): autonomous with the integration of photovoltaic, made of an adobe with the help of one mold. This lamp can orient the climbers - walkers(FIG.7). The environmental footprint of the structure: Through this exercise the students also experienced the monitoring of their constructions in relation to time and weather conditions, and its final environmental footprint. The "totem" construction created by a group of students from the same repeating adobe was erected on the ground, without the required protective foundation of stone. The structure was brought back to earth, after days of rainy weather, as if it had never been erected (FIG.4). From the sketch to the object and its creation: kitchen countertop: The question 'why soil' raises the question of research of the original forms of everyday life. In order to understand the operation of their construction this group researches the way of traditional cooking and the use of the "estia" and its evolution. They thus recommend the multifunctional countertop: Heat insulating for food- desiccant for herbs – greenhouse for the growth of herbs and plants. Questions raised during the construction: how the positive and the negative, the empty and the complete can be realized. How to create a complete structure by removing material and how by adding (FIG.5).

Conclusion

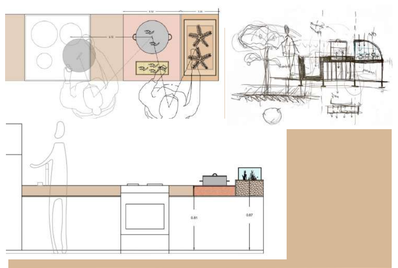
It is extremely interesting how this primordial material can lead to such contemporary crucial questions and thus become the thread of the connection between construction, composition and architecture. Students are getting familiar with various earthen construction techniques in small scale projects in order to understand the potential of raw earth in architecture. They use the properties of raw earth to strengthen the function of their proposed projects and in that way they "digest" its particular properties. It is the only design studio during their studies at the School of Architecture of TUC that they can participate and deal with 1/1 scale models and natural materials. Through their constructions, the participants have the opportunity to approach the concept of «building», and consequently the «dwelling» and «thinking», as defined by Heidegger in 1951, as the basic elements that define the relationship of human with space.

FIG. 1. Experiments outdoor the Bioclimatic and earthen Design Lab

FIG. 2. Varius experimental works on Bioclimatic and earthen Design Lab

FIG. 3. Construction of a sound-absorbing-echosmotic wall from raw earth. GROUP OF STUDENTS: BAKNIS-KADA -SABANI

FIG.4.Construction of a" totem " direction for walking routes
GROUP OF STUDENTS:STAMATAKIS -TSOUGANAKI-FRANGEDAKIS



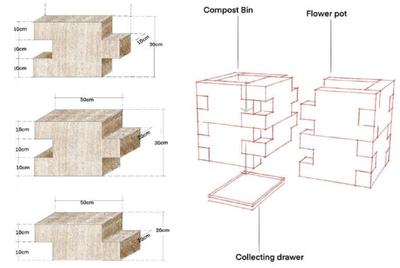


FIG.5. Construction of a" super – countertop " kitchen with multiple properties from raw earth. GROUP OF STUDENTS: ARAPAKI-DERMITZAKIS-BOUYA

FIG. 6. Plant container construction and composter.
GROUP OF STUDENTS: VELLI -PAPADOPOULOU- HANIKIAN

FIG.7. Construction from a repeating unit of raw plinth-lamp for walking routes.
GROUP OF STUDENTS: GIAMPILIS-PETRAKOPOULOS -MOISIDOU

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Earth Modular Building: Best Practices Manual & Blockchain-based Certification

THIAGO MARTONI, INSTITUTE ECOTERM® - HÉLIO DIAS, CEAA CRATERRE ENSAG

TRAINING (PROGRAMS, PROFESSIONAL CERTIFICATION, LOCAL ANCHORING, ETC.)

Summary

Earth Modular Interlocking Blocks offer a promising alternative in the civil construction industry. Despite the abundance of online how-to videos for this building technique, many present incorrect approaches that can lead to complications. These issues often arise due to a lack of knowledge, despite the good intentions of builders and manufacturers. Therefore, access to accurate information that can contribute to sector development and provide proper guidance on the care and execution of construction with modular interlocking blocks is crucial.
In this study, we also explore the Cardano blockchain to implement our certification system, an international, permissionless, and decentralised network. This system ensures credibility and will help us promote global recognition of earthen building practices. Thus, the aim of this study is to elaborate on a Best Practices Manual for Building with Compressed Stabilised Earth Modular Blocks and implement a Blockchain-based Certification system.

Introduction

The global significance of sustainable civil construction has grown in recent years, driven by a focus on resource reduction, environmental concerns, and the increasing emphasis on social responsibility within the industry. In this context, earth modular blocks offer several advantages for construction, including cost savings, expedited construction timelines, reduced construction waste, cleaner construction sites, and enhanced thermal and acoustic comfort. Among these benefits, the design feature of interlocking blocks plays a significant role in streamlining the construction process, thereby boosting overall efficiency.
However, working with modular materials necessitates specific precautions that differ from those in conventional construction methods. Therefore, it is crucial to establish guidelines and instructions for the use of these materials to foster sector development and ensure proper execution of construction with earth modular interlocking blocks. Establishing quality standards in sustainable construction presents a broader challenge. Consequently, the establishment of an international blockchain-based certification system is imperative to authenticate and validate sustainable construction practices, particularly focusing on earthen building techniques, and to promote their recognition and acceptance worldwide. Blockchain-based certification enhances trust, transparency, and efficiency in certification processes, benefiting both consumers and businesses.

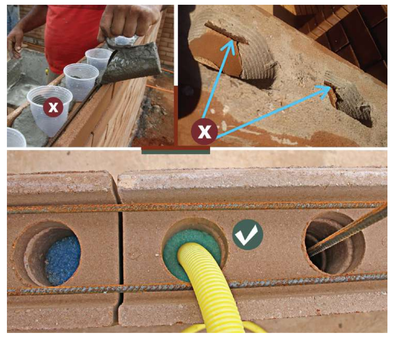
Methodology

The creation of the technical construction manual for modular blocks stemmed from a partnership between Ecoterm Modular, the State University of Minas Gerais, and Morro Verde Mining.
Institute Ecoterm spearheaded this transformative initiative in sustainable construction, prioritising education and training while producing earth modular bricks. The study involved collaboration with engineers and undergraduate engineering students from the State University of Minas Gerais. Together, they formed discussion groups to prepare and practice the Best Practices Manual for Building with Compressed Stabilised Modular Earth Blocks.
Furthermore, Institute Ecoterm delved into researching the latest advancements in technology, leading them to explore Web3 technology and utilize the Cardano blockchain, enabling the implementation of an international certification system.

Results

The Best Practices Manual for Building with Compressed Stabilised Modular Earth Blocks, which we elaborated, is accessible for free on « *www.ecoterm.org* ».
Originally available in Portuguese, it has been accessed by thousands and, in response to international demand, translated into other languages to break down language barriers and empower communities worldwide. This translation is currently undergoing approval by entities in the respective native-speaking countries to ensure validation.
Within the manual, we address and debunk methods that present incorrect approaches, providing explanations and demonstrating the correct approach. It serves as didactic material in courses organised by Institute Ecoterm and its partners. Recently, the French version played a crucial role in a workshop in Gabon as part of our members' volunteer work.
Overall, the manual helped to rectify previously incorrectly used techniques, with some examples outlined below. One misconception we addressed in this manual is the placement of reinforcing steel clamps within the blocks.
Traditionally, bricklayers would cut the blocks just enough to accommodate the U-shaped steel clamps, positioning them between the vertical steel rods. However, this method left the steel insufficiently covered by concrete, leading to potential oxidation, and compromised structural integrity over time.
To address this issue, we developed an alternative approach. Rather than placing the U-shaped steel with its legs facing down, we positioned it with the legs facing up. Additionally, we securely tied this U-shaped steel to the vertical reinforcing steel in a manner that positions the "U" clamp in the middle of the block. This adjustment combined with a larger block cut, ensure that the concrete will completely envelop the steel, resulting in a significantly stronger and safer structure in the long term.

We've also been focusing on refining another key technique, particularly during the concreting process of the channel blocks. Traditionally, plastic cups were used to cover the air ducts within the bricks to prevent concrete from filling the entire structure.
However, this method posed a risk to the reinforcing steel within the horizontal channels. The issue arose because the plastic cups would touch the edges of the steel rods, leading to incomplete coverage by concrete once the cups were removed. This exposed area left the steel vulnerable to oxidation. To address this challenge, we've proposed alternative approaches.



For instance, one method involves using a smaller diameter hose that still allows the cavity to remain open while ensuring the concrete fully covers the steel. This adjustment maintains structural integrity while mitigating the risk of oxidation caused by inadequate concrete coverage.
Regarding the results of recognition and certification of products and manufacturers, the Institute Ecoterm entered the Web3 domain and found Cardano, a sustainable proof-of-stake blockchain. This led to our Earth Natives NFT project, an educational initiative comprising a collection of 3,333 unique arts and minerals. Each NFT includes essential mineral details: name, image, hardness, and scientific formula, serving as an open-source, library on blockchain. Proceeds from this collection were used to build and donate a house to a family in precarious living conditions. The entire process was documented, from demolishing their former shack to constructing a new home with compressed stabilised earth modular blocks « *www.earthnatives.io* ».

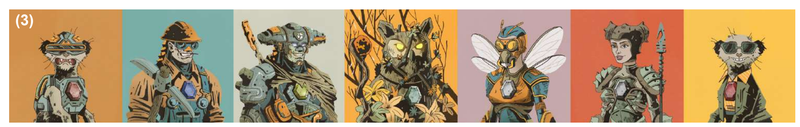
Conclusion

The Best Practices Manual for Building with Compressed Stabilised Modular Earth Blocks offers indispensable guidance for both professionals and informal workers, highlighting the importance of efficiency, safety, and excellence in construction methods. Moreover, we are preparing to implement blockchain-based certification. This initiative targets the certification of earth-based products and builders with the goal of establishing credibility and achieving global recognition for earthen building practices.

From top right to bottom right, we have: (1) EcoCamp 2021 with a preview of the Manual, (2) EcoCamp 2022 in collaboration with Clay Nation, (3) a selection of Earth Natives NFTs by the Brazilian artist João Montanaro, and (4) the 2023 volunteer workshop in Gabon,

(1)

(2)


(3)

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UNESCO CHAIR earthen architecture, building cultures and sustainable development

2-4 July 2024
Grenoble (FRANCE)

Sensibilización y apropiación de la construcción con tierra en escenarios con vocación turística. Caso De la tierra Casa Taller en Barichara, Colombia

LINA MARIA PIERUCCINI ARIAS - DE LA TIERRA CASA TALLER - LAB

PALABRAS CLAVE: TURISMO – CULTURA – SOSTENIBILIDAD – EXPERIENCIAS – ECONOMÍA

De la tierra Casa Taller es un espacio de experiencias de interacción, interpretación y conocimiento de la tierra como material; desde la construcción hasta la expresión. Está dirigido a todo público.

¿Quiénes somos?

De la tierra Casa Taller es un espacio de experiencias de interacción, interpretación y conocimiento de la tierra como material; desde la construcción hasta la expresión. Está dirigido a todo público.

Localización

Estamos en Barichara un municipio de origen colonial (1705) en Santander, Colombia. Declarado patrimonio cultural en 1978 por su preservación arquitectónica y la vigencia del oficio de la tapia pisada.

¿Qué hacen quienes visitan De la tierra Casa Taller?

(1) Pintura con tierras de colores. No se requiere ser artista para pintar con la tierra pues es tan expresiva que un diseño sencillo termina conmoviendo al más escéptico.
(2) Experiencias de construcción en escala pequeña: Aproximación a los conceptos básicos de las técnicas de tapia pisada y bahareque. En la tapia se arma el tapial desde la lúdica, se prepara la tierra al punto de humedad. Luego se compacta

para obtener el murito de tapia pisada. En el bahareque el participante recibe la estructura vegetal, la tierra y la fibra. Mezcla la tierra, fibra y agua hasta llegar a un estado plástico. Realiza el embarrado de la estructura vegetal hasta llenarla (3) Elaboración de terrarios como souvenir: Entregamos una botellita y el participante la va llenando con tierras de colores. (4) Talleres a campo abierto en escala real para grupos con interés técnico. Se abordan aspectos técnicos profundos de la construcción con tierra. Se maneja un enfoque social con los participantes.

Se construyen habitaciones de bahareque en el sector rural. Esto representa un beneficio a la familia campesina que acoge a los grupos.
Los talleres y experiencias pasan por un conocimiento sensorial de la tierra como material antes de pasar a aspectos específicos. Se siembra en el participante una reflexión sobre

el concepto de bienestar, respeto y empatía por el planeta. Reconocemos las casas de tierra, como entes vivos que transmiten y se expresan. Resaltamos el componente de sostenibilidad del uso de la tierra. Cada objeto que se lleva se convierte en conector de recuerdos y reflexión para el visitante.
Son dos sedes, en donde se cuenta con exposiciones, muestras, fotografías y conceptos sobre la construcción.

¿Origen?

Una casualidad. En el 2005, un grupo de niños con un guía buscan a Santiago Rivero para proponerle que les hiciera un taller de tapia pisada. Había llovido ese día y el colegio no permitía hacer rafting al día siguiente. Santiago, recién llegado de Francia luego de hacer la formación de Arquitectura de tierra en CRATerre-EAG 2004, nunca imaginó estar con niños de 10 años en actividades con la tierra. A la mañana siguiente se tenía un circuito de 4 estaciones con diferentes técnicas de construcción con tierra. La sorpresa llegó dos semanas después cuando Santiago recibe la llamada de la agencia que promueve viajes experienciales. El taller había sido de las actividades que más les había gustado a los niños. Este fue el origen de De la tierra Casa Taller.

Con el tiempo y el voz a voz más grupos buscaron a Santiago para hacer los talleres de construcción con tierra. Para 2012, Santiago decide asumir formalmente los talleres pues pasan más de 1000 niños al año y más de 200 estudiantes de universidad.
En el 2017 ya posicionados los talleres a campo abierto dirigidos a niños y estudiantes, aparece Lina Pieruccini en la vida de Santiago y De la tierra casa taller. Juntos identifican que quienes tomaban los talleres a campo abierto eran grupos que venían dispuestos a una experiencia física de tomar herramientas y construir; en temporada baja y entre semana. Identifican que los turistas que venían a Barichara en temporada alta y fines de semana se quedaban en el gesto fácil de tomar la foto y marcar un destino más en su lista sin comprender qué es lo que hace a Barichara especial. Fue revelador constatar que no había nadie y nada que les contara a los turistas la importancia de la construcción con tierra en un lugar como Barichara. A partir de aquí nace la idea de crear un espacio físico con disponibilidad permanente de experiencias con la tierra bajo un formato de turismo cultural.

¿Qué resaltamos?

Lugares con patrimonio cultural de construcción con tierra existen varios, con mayor y menor grado de conservación, pero dinámicas económicas alrededor de ese patrimonio que no están relacionadas directamente con la construcción o la restauración son muy pocas. Procuramos mostrar y poner en valor la construcción con tierra y despejar dudas e imaginarios que surgen alrededor de algo que se quedo en pasado y que para algunos solo existe en la memoria de sus abuelos.
Los ejercicios y trabajos que realiza la academia son importantes para darle fuerza, contenido

De la Tierra
Casa Taller
Barichara - Colombia

a los conceptos y a la técnica, pero a veces el mensaje solo llega al nivel técnico y profesional. Desde nuestro ejercicio se difunde e irrigando el concepto a diferentes niveles.

Para reflexionar

Se busca que quien nos visita o realice las experiencias se lleve una reflexión de sostenibilidad en la construcción, de valoración de las tradiciones y sobre lo que significa la felicidad y el bienestar, observado desde un enfoque de la belleza de lo simple y visto desde lo esencial.

Conclusión

A partir de nuestra experiencia, consideramos que, en lugares con vocación turística con antecedentes patrimoniales con tierra, un modelo similar a De la tierra Casa Taller, aporta en la sensibilización y apropiación de la tierra como material, tanto en el turista como en la población local. Es un modelo que, al posicionarse, no depende el Estado o de alguna entidad para su desarrollo y gestión, permitiendo que pueda desarrollar acciones con continuidad. Siendo un modelo con un enfoque sencillo, práctico permite visibilizar y sensibilizar sobre el material tierra a diferentes capas de la población lo que es una propuesta diferente y complementaria a la que se plantea desde la formación académica o técnica.

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UNESCO CHAIR earthen architecture, building cultures and sustainable development
2-4 July 2024 Grenoble (FRANCE)

Experiencia de Enseñanza y Aprendizaje en el Diplomado de Arquitectura Contemporánea en Tierra - Universidad de Santiago de Chile (USACH)

VALDÉS, CAROLINA - ACEVEDO, ROMINA - - BROUGTHON, JORGE - UNIVERSIDAD DE SANTIAGO DE CHILE

FORMACIÓN

Resumen

Ante la creciente necesidad de programas académicos que aborden la sostenibilidad de manera integral, combinando el conocimiento del patrimonio cultural, las prácticas constructivas locales y las nuevas posibilidades que surgen a partir del trabajo con materiales y tecnologías contemporáneas compatibles, ha surgido el Diplomado de Arquitectura Contemporánea en Tierra como uno de los referentes pioneros en Chile en esta materia. Este programa, ofrecido en modalidad virtual, responde a la imperiosa tarea de reinterpretar el patrimonio, en línea con las demandas de un mundo de cambios y en constante transformación. Su desarrollo ha sido posible gracias al compromiso y liderazgo del cuerpo docente de la USACH - Universidad de Santiago de Chile - quiénes han adaptado la metodología de enseñanza para garantizar la inclusión de estudiantes tanto nacionales como extranjeros, a través de una modalidad de enseñanza semi-presencial, que integra clases teóricas online y un módulo práctico presencial condensado, permitiendo que estudiantes de lugares lejanos puedan participar de éste. Desde su inicio en 2022, este diplomado, con una duración de un semestre, ha destacado por su enfoque innovador y su capacidad para integrar diversas perspectivas en el ámbito de la arquitectura y construcción sostenible con tierra.

Introducción

El Diplomado surge como respuesta a la necesidad de expandir la enseñanza de la arquitectura y la construcción en tierra en Chile, con un enfoque destacado en el desarrollo de proyectos de vivienda y la exploración de alternativas ambientalmente sostenibles en el contexto de la actual crisis climática. En este marco, se plantea cómo proyectar el uso de la tierra como un material contemporáneo y apropiado para el futuro, estableciéndose como una opción educativa distintiva. Diversas oportunidades surgieron en el contexto post-pandemia gracias a la utilización de plataformas digitales, facilitando la difusión y posibilitando el acceso a la educación en regiones distantes de la universidad. Profundizar en el diseño estructural de sistemas mixtos de madera y acero para sistemas constructivos mixtos de tierra.

Fig. 01_Proceso constructivo en módulo presencial.

Metodología

La metodología del programa es capaz de integrar teoría, diseño proyectual y experimentación de manera virtual para las sesiones teóricas, reservando lo presencial para el último módulo práctico, estructurando el programa a través de 5 módulos, cada uno, con enfoque específicos que incorporan teoría y práctica: Arquitecturas de tierra, Hábitat y vivienda sostenible, Sistemas mixtos de construcción en tierra, Laboratorio de proyecto y Laboratorio de Tierra. Los primeros cuatro módulos son realizados a través de clases sincrónicas por medio de la plataforma zoom, y el último módulo presencial, se realiza durante seis días de clases presenciales, en el campus de la Facultad de Arquitectura y Ambiente Construido de la Universidad de Santiago de Chile.

El principal recurso de enseñanza-aprendizaje se centra en el desarrollo de un encargo sumativo, que originalmente se concibió a partir del primer módulo, pero que en la práctica se inició a partir del módulo de "Sistemas mixtos de construcción en tierra". A través de este encargo, los estudiantes desarrollan un proyecto de vivienda con ciertas particularidades, que deben dar respuesta a las condiciones climáticas y geográficas del territorio en que habitan, a partir de la elección de un sistema constructivo mixto de construcción con tierra; para luego centrarse en el diseño y desarrollo de un prototipo constructivo en el módulo de "Laboratorio de proyecto", que construyen durante el módulo presencial de "Laboratorio de tierra".

Resultados

El Diplomado en Arquitectura Contemporánea de Tierra ha logrado resultados significativos, reflejados en la calidad de los proyectos desarrollados por los estudiantes, gracias a su enfoque innovador y a la integración de una metodología que combina lo virtual y lo presencial.

En primer lugar, el programa ha generado un alto interés entre los estudiantes al ofrecer una formación especializada en arquitectura en tierra y ambientales que respaldan su uso desde tiempos antiguos hasta la actualidad. La implementación de sesiones virtuales ha permitido una mayor flexibilidad y accesibilidad para los participantes, facilitando su participación desde diferentes ubicaciones geográficas. Esto ha ampliado la cobertura del programa, posibilitando que estudiantes de territorios alejados puedan acceder a una educación de calidad en arquitectura en tierra, lo que antes podría haber sido limitado por la distancia física a la universidad. Además, la combinación de teoría, diseño proyectual y experimentación virtual ha enriquecido la experiencia de aprendizaje, proporcionando a los estudiantes las herramientas necesarias la comprensión y el aprendizaje, abordando de manera integral las bases históricas, culturales, territoriales, técnicas y constructivas del material. La modalidad semi presencial, ha permitido consolidar el aprendizaje a través de la experiencia directa, reforzando los conocimientos adquiridos de manera virtual. La incorporación de un equipo docente internacional ha contribuido a enriquecer las discusiones y perspectivas dentro del programa, destacando los avances de Chile en el campo de la arquitectura en tierra a nivel global. Esto ha fortalecido la reputación del programa y ha posicionado a Chile como un referente en esta área.

Conclusiones

El Diplomado en Arquitectura Contemporánea de Tierra ha logrado resultados sobresalientes al desarrollar un programa semi-presencial que promueve el interés y la consolidación de la enseñanza de la arquitectura en tierra desde Chile. Esto se ve reflejado en la calidad de los proyectos desarrollados por los estudiantes, aportando así en el avance de Chile en temas de arquitectura sostenible a nivel internacional, y en el desarrollo de innovaciones que surgen a partir de la valoración de la herencia constructiva local. El desarrollo de este programa nos permite difundir estos avances y aportar al conocimiento a través de un equipo de docente y expertos que forman parte integral del programa.

Fig. 02_ Prototipos construidos en escala 1:1 durante enero del año 2024, en la segunda versión del programa.

Fotografía: Equipo TierraLab

Fig. 03_ Proceso de trabajo en prototipos construidos durante 1era versión del programa, enero 2023

Fig. 04_Proceso constructivo en módulo presencial.

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2-4 July 2024
Grenoble (FRANCE)

Advancing Earthen Structure for Sustainable Temporary Housing: A Case Study in Turkey

VEYSI ALTINTAŞ, NURETTIN EKINCI, EVRIM SOLHAN, ÇISEM BOZBEK, MARCEL MALLET- MODERN EARTH STRUCTURE PLATFORM-NKNC ARCHITECTURE

PARTNERSHIP AND MULTIDISCIPLINARITY

Summary

This study explores earthen construction in Turkey, focusing on challenges and opportunities. Aligned with Terra Education IV's 'Partnership and Multidisciplinarity' theme, it emphasizes collaborative efforts to advance eco-friendly architecture. The goal is to enhance temporary shelter construction using earth materials. By fostering partnerships and multidisciplinary collaborations, the research promotes collective action to mainstream earthen architecture. It underscores knowledge-sharing and engagement across disciplines, envisioning earthen buildings as key to sustainable development, climate change mitigation, and energy crisis solutions.

Introduction

Traditional residential buildings prioritize personal living spaces, protection, and healthy environments. However, disasters like the February 6, 2023 earthquakes highlight the urgent need for temporary shelters. Earthen structures, more economical and sustainable than concrete or steel, offer superior benefits in health, comfort, and energy efficiency. Following these earthquakes, the Modern Earth Structure Platform and NKNC Architecture proposed ALKER, a compressed adobe

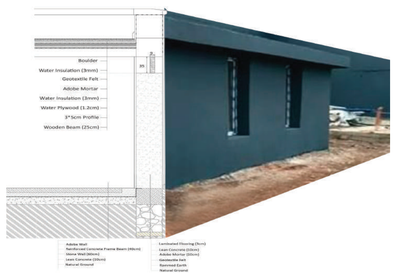
Photo of the prototype project in Tuzla, Istanbul by NKNC Architecture

material. ALKER (Stabilized Adobe with Gypsum and Lime),surpasses containers in comfort, health, thermal conductivity, and cost-effectiveness, making it a practical choice for fast, eco-friendly temporary housing solutions.

Methodology

This study evaluates the performance of container structures, commonly used as emergency shelters in Turkey, against ALKER structures produced using rammed earth construction techniques. Both structures were assessed in terms of production and usage performance within the same dimensions.

The evaluation compared container structures with ALKER structures of similar dimensions, aiming to showcase the potential of earthen structures as a viable alternative for temporary housing post-disaster. The focus was on fast, economical, and



Section of the prototype project in Tuzla, Istanbul by NKNC Architecture

sustainable production methods.

Technical Details of ALKER

Inspired by traditional Anatolian adobe houses, Ruhi Kafescioğlu* began researching «ALKER» (gypsum-stabilized adobe) at Istanbul Technical University (ITU) in 1947. By 1975, he initiated stabilization studies using plaster, leading to the creation of ALKER in 1980. The first trial building was constructed at ITU Ayazağa in 1983. Kafescioğlu promoted ALKER until his retirement in 1986, subsequently forming a working group for its further development and education.

ALKER, a mixture of earth stabilized with gypsum and lime, significantly improves physical and mechanical properties compared to unmodified adobe. By adding 10-20% gypsum and 2% lime to well-graded earth, the mixture gains a skeleton structure, reducing clay particle movement and minimizing shrinkage and cracks during drying. Tests show unstabilized earth's compressive strength is 5-10 kgf/cm², while ALKER's is 35-60 kgf/cm², with strength increasing over time.

ALKER's unit weight is 1.6 kg/lt, lighter than traditional earth (1.70 kg/lt), and its thermal conductivity is 0.40 λ (kcal/mhc) compared to 0.80 λ (kcal/mhc) for traditional adobe. This makes ALKER structures lighter and more energy-efficient, enhancing thermal comfort and reducing fuel costs. Additionally, ALKER is less sensitive to water, maintaining integrity where traditional earth mixtures disintegrate.

Using compressed earth techniques for ALKER accelerates production, reducing labor and drying time compared to block techniques.

Interdisciplinary Approach

The lack of standards and regulations regarding earth-based materials in Turkey limits the utilization of local resources and reinforces negative perceptions about such materials. However, local materials hold great potential, especially for emergency shelter areas. This study adopts an interdisciplinary approach to unlock this potential and raise awareness about the use of local materials.

As architects and urban planners, we have conducted both theoretical and practical applications concerning earth structures and local materials. We have participated in projects related to earthquake housing and emergency shelter areas, focusing on the use, durability, and aesthetic qualities of ALKER material. Integrating knowledge and experience from various disciplines leads to more innovative and sustainable solutions.

A pilot project in Tuzla provided insights into the performance of local materials under real conditions in earthquake-prone areas. Observations were made to understand how these materials fare in actual scenarios.

The absence of standard regulations concerning earth structures in Turkey hinders their widespread adoption, increasing uncertainties about their safety, durability, and sustainability. To address this, we submitted an application to the Turkish Ministry of Housing to establish technical standards for earth-based materials and ensure their acceptance nationally.

Photo of the prototype project in Tuzla, Istanbul by NKNC Architecture

Photo of the prototype project in Tuzla, Istanbul by NKNC Architecture

Additionally, NKNC Architecture engaged in discussions with the Turkish Disaster and Emergency Management Authority (AFAD), presenting the pilot project. Efforts are ongoing to develop standards and regulations for earth structures within the scope of Urbanization and Disaster Management.

This interdisciplinary effort promotes local materials for resilient, sustainable structures, meeting immediate shelter needs and long-term urbanization goals.

Results

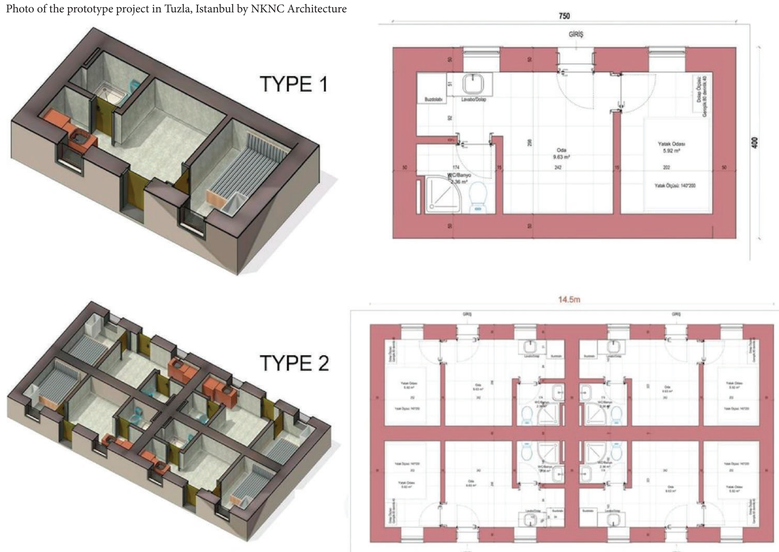
To promote earth-based shelters, a 'Temporary Living Unit Production Manual in the Earthquake Zone' was published on social media, simplifying the construction process. The Tuzla, İstanbul prototype used a 4-piece modular system, reducing costs and allowing rapid construction of 40 units per day with ten teams. Preliminary studies show ALKER units cost nearly half of traditional container constructions. ALKER's production energy is 0.7 MJ/kg compared to steel's 38 MJ/kg, and its thermal conductivity is 0.40 W/m°C versus steel's 35 W/m°C, indicating significant cost savings in both construction and air conditioning.

Conclusion

This paper highlights the current state and future vision of earthen structures in Turkey, aligned with the Terra Education IV conference theme. Collaboration among the Modern Earth Structure Platform, NKNC Architecture, and the community aims to advance sustainable earthen architecture. Earthen materials show promise for emergency shelters, offering ecological benefits and resilient designs. The study advocates for earth construction over containers, promoting environmental responsibility and comfortable living.

* Bilge Işık, B. (2021). ANMA Dünyaya «Alker» Çalışmalarıyla Katkı Sunan Ruhi Kafescioğlu. Mimarlık Dergisi, (417), January-February 2021.

Photo of the prototype project in Tuzla, Istanbul by NKNC Architecture



Plan and axonometric views of two types of the prototype project from the Temporary Living Unit Production Manual in the Earthquake Zone

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Tierra Lamp, Serie Itata. Técnicas Patrimoniales de Construcción con Tierra Llevadas al Diseño de Objetos Lumínicos Contemporáneos. Chile

ACEVEDO, ROMINA - NAVARRO, KONSTANZA - RIQUELME, CLAUDIA - TRONCOSO, MATÍAS - TIERRA LAB

SECTORES PRODUCTIVOS - INNOVACIÓN

Resumen

Tierra Lamp combina investigación, diseño y sostenibilidad. Es un proyecto liderado por el equipo Tierra Lab (Laboratorio de investigación y experimentación en torno a la tierra como material óptimo para el Diseño, la arquitectura y la construcción sustentable) Marca el inicio en la investigación en torno al diseño de objetos con la materia tierra, centrándose en la creación inicial de una serie de lámparas inspiradas y materializadas en el territorio del valle del Itata, zona centro sur de Chile. Tierra lamp, se emplaza en este territorio de arquitecturas centenarias en tierra ligadas a la producción vitivinícola, añadiendo un contexto cultural y geográfico al proyecto.
La primera etapa y serie es ejecutada en el año 2023 y fué financiado por el Fondo Nacional de Desarrollo Cultural y las Artes (FONDART) del Ministerio de las Culturas, las Artes y el Patrimonio del Gobierno de Chile, bajo la modalidad de creación de Diseño.

Introducción

Tierra Lamp busca la puesta en valor la cultura constructiva en tierra del valle del Itata de la región de Ñuble, Chile, a través del diseño de objetos lumínicos, rescatando técnicas de construcción con tierra centenarias ligadas a la producción vitivinícola de la zona para llevarlas al área del diseño contemporáneo de objetos.
De este proceso de creación surge la primera serie de lámparas de interior denominada "Itata", que permite la exploración tanto de la materia tierra como de la luz. Las piezas de diseño resultantes buscan reflejar la identidad cultural del territorio bajo una mirada innovadora y contemporánea, desafiando la materia tierra en otras áreas de exploración artísticas, en este caso en el diseño de objetos. Si bien, en esta primera etapa no contemplamos procesos que incorporen las variables de la comercialización, traslados, packaging, durabilidad, etc, son parte de los desafíos que vienen en la segunda etapa del proyecto.

Metodología

Las etapa inicial parte con el análisis de la cultura constructiva en tierra del valle del Itata, que permite comprender como se desarrolló el oficio constructivo con la tierra, dando luces de como poder abordar la materia tierra y poder llevarlas al mundo del diseño de objetos. Una vez identificadas las técnicas constructivas, se procede a definir una de ellas para la elaboración de la serie y así poder acotar el campo de investigación, en este caso se utilizó la técnica de tierras apisonadas.
En paralelo se llevó a cabo un análisis detallado de la materia luz para fundamentar el diseño de las lámparas inspiradas en este territorio. Luego de la etapa de diseño y prototipos en 2D se procedió a la ejecución de la serie, comenzando con la recolección de 20 muestras de tierra 30kg c/u de diversos lugares en torno al valle del Itata. Cada una de las muestras fueron georeferenciadas, luego caracterizadas con el fin de comprender su comportamiento para la elaboración de objetos de diseño mediante la técnica de tierras apisonadas. Se realizaron ensayos de -sedimentación, pastilla, placa, granulometría, y testigos de tierras apisonadas sin estabilizar, para luego llevarlas a la escala final, además de una caracterización cromática según el sistema RGB.
Con la información recopilada, se procedió a la estandarización de las mezclas y proporciones de tierras optimas para la ejecución de prototipos y el estudio de desencofrado de moldajes lo que implicó un periodo de prueba de error de 4 meses para encontrar las proporciones y modelos adecuados para los apisonados. Este proceso condujo a la creación de los modelos que componen la serie, cada uno abordando de manera única la luz, la escala y los desafíos de esbeltez de cada una de las lámpara.

Resultados

El resultado decanta en la primera serie de lámparas del proyecto Tierra Lamp denominado "Serie Itata" Son 6 Lámparas de tierras ejecutadas con la técnica de tierras apisonadas inspiradas y materializadas en el valle del Itata, zona centro sur de Chile. Se materializa en una gama de representaciones lumínicas que permiten visualizar las posibilidades que nos da la tierra y la luz para el diseño de objetos utilitarios contemporáneos. llevamos la escala de la arquitectura a un espacio acotado de lámparas en diferentes dimensiones que van desde los 15x15cm a 30cmx90cm de alto, . Además toda la metodología utilizada está inscrita en un manual impreso del paso a paso que permite comprender la ejecución y también abrir una ventana para seguir explorando en torno a la materia tierra y la materia luz. El trabajo con la tierra más allá de la arquitectura permitió explorar en otra escala y usos con esta técnica constructiva. Además a través del análisis se logró identificar 6 técnicas constructivas patrimoniales en tierra en la zona; Quincha, Adobe, Adobe pandereta, Adobe encofrado con estructuras de madera, tierras apisonadas para pisos y Cob.

Conclusiónes

Tierra Lamp constituye un proyecto pionero en Chile, que abre nuevas perspectivas para desafiar la materia tierra y explorar diversos ámbitos creativos más allá de la arquitectura. La aplicación de las tierras apisonadas en este proyecto marca el comienzo de una amplia exploración en este campo. El proyecto nos abre nuevos desafíos como el seriado, el peso, el transporte, la estabilidad estructural y la durabilidad a lo largo del tiempo, entre otros que tienen directa relación con el ingreso al mercado de este tipo de objetos. Los biomateriales como la tierra, desempeñan un papel crucial en la adopción de tecnologías que reinterpretan nuestro patrimonio constructivo de manera innovadora. La ejecución de la Serie Itata ha sentado las bases para una exploración más amplia en términos de técnicas y áreas geográficas. Actualmente, nos encontramos en proceso de desarrollo de la "Serie Biobío" de Tierra Lamp, donde estamos trabajando con otras técnicas mixtas de quincha y cob, que tiene una relación directa con la puesta en valor y difusión de la cultura constructiva en tierra de estos territorios a través de estos desafíos con la materia y el diseño.

fotografía Tierra Lamp, Serie Itata. Manuel Morales

Proeceso de Construcción de la serie.

Ministerio de las Culturas, las Artes y el Patrimonio
Gobierno de Chile

Proyecto financiado por FONDART Nacional, Linea circulación internacional de contenidos 2023 Folio:734964

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UNESCO CHAIR earthen architecture, building cultures and sustainable development

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Grenoble (FRANCE)

Recuperación de residuos de la industria del tequila para la producción de adobes y su implementación en proyectos sociales de Jalisco, México

ANA ROSA OLIVERA BONILLA, INSTITUTO TECNOLÓGICO Y DE ESTUDIOS SUPERIORES DE OCCIDENTE - ITESO

DISEÑO, CONSTRUCCIÓN Y REGULACIÓN DE LA CONSTRUCCIÓN CON TIERRA. DESECHOS DE LA INDUSTRIA DEL TEQUILA EN UN PAISAJE PATRIMONIAL

La ciudad de Tequila, Jalisco

Tequila es una ciudad y cabecera municipal del estado de Jalisco. Está ubicada en el valle del Río Grande, cerca de una barranca y un volcán donde las geoformas comparten el mismo nombre y propician el cultivo de una especie de planta suculenta, denominada agave.

El nombre de Tequila proviene de la palabra náhuatl Tecuilan, que significa; lugar de tributos. Su población actual supera los 30mil habitantes y según la Secretaría de Turismo Jalisco, en el año 2023 recibió alrededor de 1.4 millones de turistas.

Tequila Jalisco, México
Localización, paisaje agavero y contexto.

En sus orígenes estuvo habitado por las etnias chichimecas, otomíes, toltecas y nahuatlacas quienes utilizaban los agaves para la producción de bebidas, azúcares y fibras. El aguamiel es la savia dulce que se extrae de la planta y una vez fermentado se le conoce como pulque. Sin embargo, no fue sino hasta después de la conquista que los españoles de los siglos XVII y XVIII encabezaron las primeras destilerías de una bebida elaborada con la planta de agave y que actualmente se conoce con el nombre de tequila (Gentry 1982).

De acuerdo NORMA Oficial Mexicana NOM-006-SCFI-2005, Bebidas alcohólicas-Tequila-Especificaciones, la única especie admitida para la fabricación del Tequila, es el Agave tequilana weber variedad azul, mismo que debe se cultivado y preparado con el material extraído, en las instalaciones de la fábrica de un productor autorizado ubicado en el territorio comprendido en la Declaración.

Norma Oficial Mexicana

Patrimonio Cultural de la Humanidad Paisaje de agaves y antiguas instalaciones industriales de Tequila

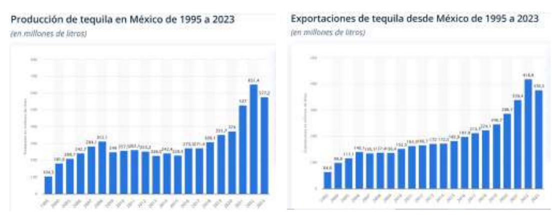
Declaratoria de la Unesco

En el año 2006, el paisaje de agaves y antiguas instalaciones industriales de Tequila se inscribieron a la lista del Patrimonio Cultural de la Humanidad de la UNESCO. 34mil 658 hectáreas, forman parte de un vasto paisaje de cultivos de agave tequilana weber variedad azul.

Hoy en día, el tequila forma parte de la identidad nacional mexicana y los paisajes de la región que comprende los territorios de Tequila, Arenal y Amatitlán Jalisco, están pintados de campos donde se cultiva el agave y los poblados cuentan con vestigios arqueológicos de cultivos en terrazas, viviendas, templos, túmulos ceremoniales y terrenos de juego de pelota que constituyen un testimonio de la cultura de Teuchitlán, predominante en la región de Tequila entre los años 200 y 900 de nuestra era.

Producción y residuos

A partir de un estudio realizado por *statista* (ver QR), en el año 2022 se produjeron alrededor de 651,4 millones de litros de tequila en México y se exportaron 418,9 litros, siendo 2 sus principales residuos; la vinaza y la fibra del agave.



Imágenes del proceso de la producción del Tequila

La fibra de agave, también conocida como bagazo, se obtiene después de la cocción y molienda de las piñas. Para producir 1 litro de tequila, se producen 5 kgs. de residuo de esta fibra. Esto quiere decir, que en el año 2022 se produjeron 32,570 millones de kilos de fibra en el país.

Por otra parte, la vinaza es un líquido color café turbio que se obtiene a partir de la destilación. Es muy contaminante si no se trata y vierte a cuerpos de agua o el suelo mismo. Hoy sabemos que por cada litro de tequila se generan en promedio 10 litros de vinaza. Si volvemos al año 2022, se obtuvieron 65,140 millones de litros de vinaza en el país.

1.- Incorporación de la vinaza.
Fotografía: Daniel Martínez Cohetero

2.- Secado y separación del bagazo.
Fotografía: Daniel Martínez Cohetero

3.- Producción de adobes con residuo de la producción del Tequila
Fotografía: Daniel Martínez Cohetero

4.- Secado de la producción de adobes.
Fotografía: Daniel Martínez Cohetero

Investigación

Durante los últimos años, en conjunto con investigadores del ITESO, industrias tequileras y asociaciones civiles, se ha buscado responder a las preguntas de cómo recuperar estos residuos de la industria tequilera y solventar la demanda de espacios habitables tanto en el municipio de tequila como el incremento de la producción del tequila ha provocado un gran número de desplazamientos de población y se requiere principalmente de viviendas, aulas pedagógicas e infraestructura para albergar a mujeres en situación de vulnerabilidad.

La propuesta ha sido el fabricar adobes a los cuales se les incorpora la fibra de agave y la vinaza cómo líquido que sustituye al agua y así obtener una tierra estabilizada y en un estado hídrico adecuado para esta propuesta de sistema constructivo.

Carpeta de proyectos

Los especímenes, fueron sometidos a estándares de resistencia en laboratorio hasta lograr tener los porcentajes adecuados para llegar a resultados óptimos y solventar ambos compromisos socioambientales: la reutilización de residuos y la construcción de espacios sociales para solventar necesidades de la

Ceniza de biomasa	Fibra de agave	Tierra	Vinaza
2%	30%	68%	100%
30.93 promedio kgf/cm2 resistencia a la compresión			

Proyectos

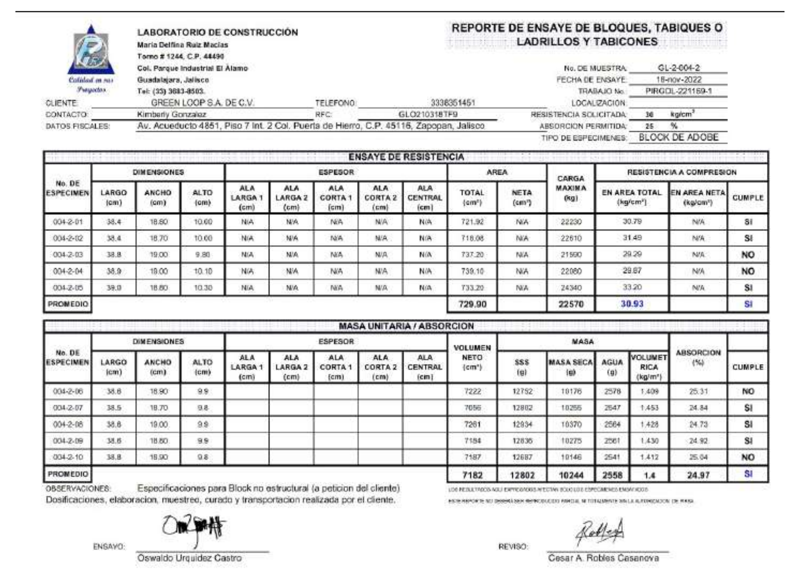
- Elaboración de adobes y pruebas de resistencia.
- Vivienda de jornalero jimador. Trabajador de la industria del agave y tequila.
- Aula para escuela primaria en Amatitán, Jalisco.
- Viviendas para trabajadores de Tequila Jalisco.
- Centro para mueres vulnerables en Jalisco.
- Colectiva Tierra. Espacio de prácticas para la construcción con tierra.
- Propuesta de normativa para la construcción con adobes en Tequila, Jalisco.

Conclusiones

El presente estudio ha permitido no solo llegar a obtener un espécimen resistente sino también a elaborar un reglamento de construcción que actualmente está en revisión por parte de las autoridades correspondientes y de aceptarse sería el primer reglamento de construcción con adobe en el país.

Esta investigación recurrió a métodos cualitativos y cuantitativos, apelando a técnicas de investigación tanto de revisión bibliográfica como al trabajo comunitario y de campo, además de pruebas de laboratorio y modelos numéricos para lograr estandarizar la calidad de un adobe tipo, socialmente aceptado e ingenierilmente resistente para solventar las necesidades de la comunidad y no solo recuperar lo residuos sino también reincorporarlos.

Actualmente los estudiantes de la Universidad Iteso trabajan en la transmisión de conocimiento y tecnologías a los habitantes de distintos municipios del estado y en el diseño de los espacios para la autoconstrucción.



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UNESCO CHAIR earthen architecture, building cultures and sustainable development

2-4 July 2024
Grenoble (FRANCE)

La brique de terre allégé comprimée (BTAC), un materiau terre-paille pour l'amélioration du confort thermique

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FILIÈRES DE PRODUCTION (INNOVATION, PRODUCTION, RECHERCHE TECHNOLOGIQUE)

Résumé

Un complexe terre-paille préfabriqué a été installé sur la maison en terre du campus de Saint-Martin d'Hères, près de Grenoble, en juillet 2023. Cette intervention a entraîné une diminution drastique de la consommation énergétique pendant la période hivernale. Cette brique, composée de terre et de paille, présente donc des propriétés hygrothermiques pertinentes pour des projets d'amélioration énergétique.

Introduction

En 2022, l'équipe d'«e-Co-LoS!», l'équipe CRA-Terre du laboratoire AE&CC, le laboratoire 3SR et les étudiants du DSA «Architecture de terre», ont entrepris d'améliorer l'efficacité énergétique de la Maison en Terre. Après une phase de prototypage et de tests de production, un millier de briques de terre allégée comprimée (BTAC) ont été produites durant le festival Grains d'Isère 2023 et leur mise en œuvre a été validée dans le cadre d'ateliers pédagogiques.

Les briques de terre allégée sont composées de paille de blé hachée et de terre de « boues de lavage », très cohésive, considérée comme un déchet de carrière. Le matériau contient un volume

BTAC en sortie de la presse manuelle

de terre pour environ vingt volumes de paille. Le mélange est comprimé dans une presse. Des lignes de production manuelles puis semi-automatiques ont été mises en place.

Méthodologie

En 2018, dans le cadre du projet "e-CoLoS!", des capteurs de suivi thermo-énergétique ont été installés dans la "maison en terre" à des fins pédagogiques, permettant de suivre les températures, les consommations électriques, le taux d'humidité, les apports solaires et la qualité de l'air. Les briques de terre allégée produites ont ensuite été caractérisées en laboratoire afin de déterminer leurs propriétés thermo-mécaniques. Une fois la maison isolée pendant plusieurs mois, les résultats ont été étudiées.

Mise en œuvre et résultats

Pour mettre en œuvre ce matériau, une couche de mortier de 5 millimètres a servi d'accroche aux briques d'environ 12 cm d'épaisseur. Un gobetis terre puis un enduit de terre fibrée taloché, noyant une trame en fibre de

Accès à la toiture après le séchage de l'enduit terre

verre et de la toile de jute ont été appliqués. Après séchage, un enduit de finition à la chaux de 6 mm termine la mise en oeuvre.

L'isolant sans finition a été soumis à des essais mécaniques caracteristiques des isolants. Ils ont notemment permis de déterminer un déformation irréversible de l'ordre du millimètre pour 30 Pa. La campagne d'essais a également validé la mise en œuvre d'un enduit terre sur parement vertical.

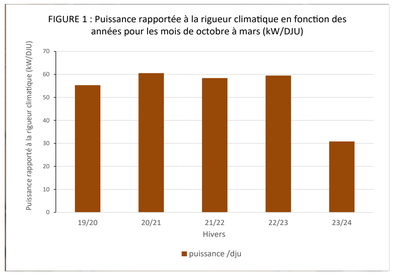
La conductivité thermique du matériau a été déterminée grâce à un dispositif appelé « plaque chaude ». Les valeurs obtenues sont similaires aux résultats de la littérature. Pour une masse volumique de 200 kg/m³, on obtient un coefficient de 0,09 W/mK, (figure 2). Avec la méthode du « hot disk », nous sommes proche des 0,08 W/mK. La conductivité thermique augmente proportionnellement à la masse volumique.

Après l'hiver 2023-2024, et l'extraction des valeurs des consommations de la maison en terre. Nous concluons que la mise en œuvre de la correction thermique a permis de réduire de 47 % la consommation totale de la maison (figure 1). Cette baisse est très importante. Elle peut s'expliquer en partie par l'amélioration de la résistance thermique de la toiture, la plus déperditive, mais également par le calfeutrage des fuites des skydomes. Des capteurs d'ambiance ont été installés en décembre 2023 et janvier 2024. 99% des valeurs sont dans la plage de confort. La consommation estimée à 186 kWh/m²SHAB pour 2024, était de 328 kWh/m²SHAB en 2022. Un bâtiment dit «BBC» consomme moins de 50kWh/m²SHAB/an.

Une potentielle industrialisation

La BTAC a été élaborée selon le contexte spécifique de la maison en terre.
Pour sa commercialisation, quatre usages sont envisageables en correction thermique :
- de toiture protégée (notre exemple) ;
- du plancher de combles perdus ;
- par l'intérieur avec un complexe de doublage ;
- par l'intérieur derrière une cloison de doublage.

Lors de leur production, les produits doivent être fidèles à la fiche technique. En effet, nous avons observé d'importantes variabilités dans les mélanges avec un même processus de fabrication. Il consistera à contrôler fréquemment la matière première (extraction, tamisage, quantités) et à veiller au respect des protocoles de production. Le format de brique, 20x20cm et d'épaisseur 12cm, a été défini en raison des voûtes et coupoles de la structure. Pour les constructions plus conventinnelles, sur parement ou toiture terrasse, un format « panneau » serait plus approprié, par exemple 1200x600 mm, couramment utilisé dans le commerce. Les diminutions du linéaire des jointures et de la manutention pourraient réduire la durée du chantier. Une épaisseur de 20 cm pour permettrait de conserver une rigidité et améliorer les performances thermiques à 2,35 m².K/W. Cette résistance thermique se rapproche



Echantillon de brique dans le dispositif «plaque chaude»

de celle de certaines laines de bois et constituerait une offre viable. En effet, 20 cm de terre-paille est équivalent thermiquement à 7,5 cm de laine de roche ou 8 cm de laine de bois.

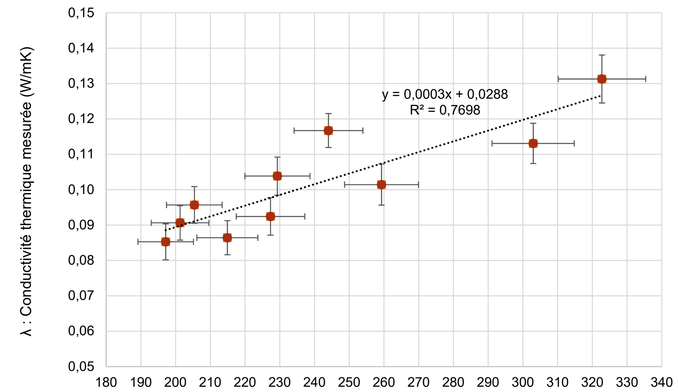
Le coût d'une BTAC a été évalué à 2€ TTC/unité, soit environ 32€ TTC/m². À titre de comparaison, les isolants industriels tels que les laines de verre, de roche ou de bois coûtent entre 9 et 20€ TTC/m² pour une résistance thermique équivalente. Il est indispensable de réduire le coût de production.

La certification de l'isolant permettrait de toucher un marché plus large. Par ailleurs, réaliser une démarche d'avis technique ou de certification Acermi, association du CSTB, est obligatoire pour prétendre aux nombreuses aides de l'État (Ma PrimeRénov', EcoPTZ, CEE...). Pour obtenir la certification, un audit de la ligne de production sera conduit et les performances du produit contrôlées. Transmettre ces résultats par un organisme indépendant permet de bénéficier d'un label de confiance (performances thermiques, acoustiques, mécaniques, réaction au feu, à l'eau, etc.) auprès des particuliers et artisans.

Conclusion

L'expérimentation sur la maison instrumentée est un succès. Les performances du bâtiment ont été améliorées et la pertinence de l'utilisation de ce matériau est validée. Cependant, l'étude du comportement thermique du bâtiment est en cours, notamment en ce qui concerne le confort d'été. Des études complémentaires sont nécessaires, telles que des essais au feu et des tests de transfert de vapeur d'eau. Une ligne de production contrôlée et robuste doit être mise en place pour garantir les performances des produits, la rentabilité et l'homogénéité de la production.

Figure 2 : Conductivité thermique mesurée en fonction de la masse volumique de l'échantillon
Essai de la plaque chaude



Toiture de la maison en Terre, 666 avenue Centrale 38400 Saint-Martin-d'Hères

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2-4 July 2024 Grenoble (FRANCE)

Ondol, a traditional Korean heating method applied to earthen architecture

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CHOI,Duk joon – Mokpo national University in South Korea – TERRAKOREA
Hwang,Heyzoo –professor, Mokpo national University in South Korea – TERRAKOREA

Summary

The Korean heating system, ondol, originated in the Korean Peninsula's ancient North Okjeo period from the 3rd to 1st century BCE. Ondol heats indoor spaces by circulating heat generated from burning wood outdoors through a system of flues beneath a floor made of stones and clay, warming the entire floor. It became a staple of Korean culture, facilitating a comfortable indoor environment and promoting sitting on warm floors. Ondol's use of wood as fuel, a renewable resource that absorbs carbon during growth and releases it when burned, positions it as a carbon-neutral heating alternative, especially in times of unpredictable weather, making it a valuable emergency fuel option compared to fossil fuels.

Introduction

Ondol, the traditional heating system of Korean hanok architecture, is fundamentally integrated into hanok, which is constructed with wood, earth, and stone, qualifying it as an eco-friendly dwelling. By examining the structure and principles of ondol, the heating method of hanok, we propose ondol heating as an efficient and climate crisis-responsive heating solution for earth-built structures, utilizing minimal fuel for comfort.

Methodology

"Ascertaining the form and type of on-dol, exploring the nomenclature and roles of each structure, along with delineating the minimum specifications, applying them to eco-friendly architectural heating facilities, and comparing the heating effects between wall fireplaces and on-dol used for indoor heating."

The main structure of Ondol

Agungi : Where to light a fire

Bulmok : "A narrow alleyway where the fire in the hearth is divided into several branches."

Buneomi : A structure in the Bulmok that allows fire to flow easily from the furnace to the whale.

Gorae : A passage through which heat and smoke pass.

Sigeundam : A pile built on the inside of an exterior wall to hang ondol stone.

Gorae Gaejari : A structure installed on the opposite side that transfers heat to the floor and collects the cooled heat and smoke and sends them to the outside.

Yeondo : Hole from the whale's to the outsider's chimney

Gulttuk Gaejari : - A structure dug deeper below the flue under the chimney (gulttuk), a structure that receives cooled smoke and moisture coming out through the flue -

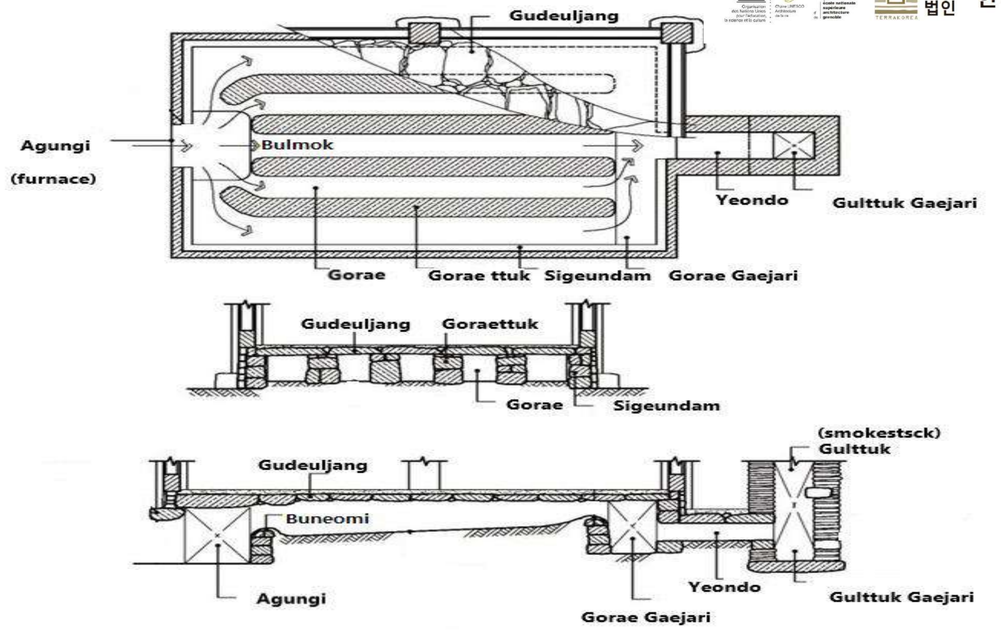
Result

Ondol heating is a method of heating indoor spaces using all three heat transfer methods: conduction, convection, and radiation, which differs from the convection and radiation heat transfer methods used in fireplace heating. While the burning-time of the flames is crucial for fireplaces, in ondol heating, it's important to combust at high temperatures. By allowing the high-temperature combustion heat to stay on the floor for a certain period, it accumulates heat in the stones and soil that make up the floor, insulating and gradually emitting the accumulated heat, thus providing efficient heating for a long time indoors.

When comparing the heat efficiency of Korean ondol heating and fireplaces, if we measure the heat emitted from the chimneys, we can see that while fireplaces emit around 80℃ to 100℃ of heat, ondol chimneys emit about 40℃ to 50℃ of heat, indicating that ondol heating is a more efficient heating method.

Conclusion

Ondol, made of earth and stone, allows heat and smoke to linger beneath the floor channels, known as "gorae," when a fire is lit underneath, gradually passing through and transferring heat to the floor. This method accumulates heat in the stone and earth floor, releasing cooled heat and smoke outdoors, compared to fireplaces, making it more efficient when using the same amount of fuel. When burning outdoors, heat and smoke pass through the separated indoor floor, expelling smoke outdoors, preventing indoor air pollution, such as fine dust, maintaining indoor comfort.



the structure of an ondol Reference : Standard Specification for Repair of Korean Heritage

the bottom of gorae

Making gorae(1)

cover with clay

Making gorae(2)

put on a gudeuljang

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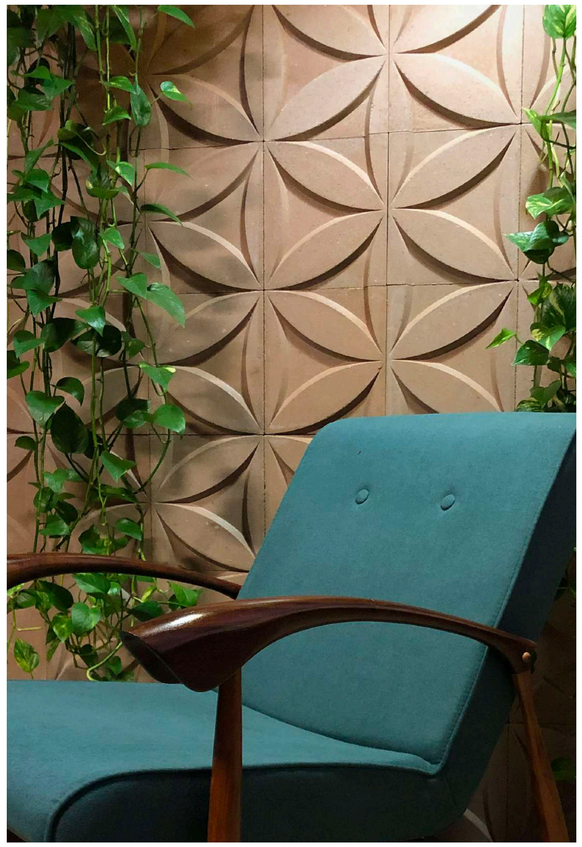
2-4 July 2024 Grenoble (FRANCE)

Transforming Compressed Stabilised Earth Block Production: A Sustainable Approach to Architectural Innovation

THIAGO MARTONI, ECOTERM® MODULAR

PRODUCTION SECTORS (INNOVATION, PRODUCTION, TECHNOLOGICAL RESEARCH)



From top to bottom, we have an image of the «Flower of Life» 3D earth tile model and its application on a wall. At the bottom, there is an image of the «Double Gap» earth breeze block model and an application of this product.

Summary

The production of compressed stabilised earth blocks has been a cornerstone in sustainable construction practices, and we now believe economic considerations are driving a shift towards innovation within this production sector. This poster details Ecoterm's exploration in Brazil of transforming CSEB production into a venture that not only aligns with environmental management and efficiency but also enhances economic viability through unique architectural features.

Introduction

Ecoterm, with a focus on modular features, shifted from conventional CSEB production to the creation of high-value products. Through machine mould alterations, the organisation now crafts breeze blocks, 3D tiles, brick shapes, and artistic wall facings, establishing a niche for distinctive and sustainable architectural solutions.

Another important aspect of this innovation lies in the incorporation of locally sourced recycled materials to address the physical properties of soil, particularly when dealing with high clay content. These materials, including industrial waste and crushed glass bottles, serve as substitutes for sand, offering additional benefits such as vibrant palettes of stylish hues and modular patterns. Moreover, repurposed construction waste, including crashed bricks and concrete, breathes new life into artistic feature walls, showcasing a commitment to creative repurposing and sustainable design. Through research and development, this endeavour has broadened the usage of CSEB manufacturing to diversify a range of sustainable and economic products.

Methodology

The production process for our modular feature products begins with sourcing raw earth material, which undergoes suitability analysis and depending on the content, adjustments may be necessary. The soil is then processed, broken down, and sieved through a 4.5-millimeter screen net. Subsequently, the soil is mixed with dry cement, usually between 8 and 12% depending on the soil type. After thorough mixing, a small amount of water is added before sending the mixture to the press machine.

One significant challenge encountered during the implementation of the new design was the occurrence of cracks in the compressed earth modules after pressing. Upon investigation, it was determined that any movement during the pressing process led to these cracks.

Precise control over pressing moulds was identified as essential to ensure uniform pressure on all sides of the block, preventing shifts in the soil that could result in surface cracks.

A critical aspect for achieving optimal finishing is passing the cement-soil mixture through a blade, functioning as a high-speed crusher. This process swiftly breaks down the mixture, ensuring a finely smashed-up consistency. After homogenizing with water, the soil mixture undergoes this crushing process, further enhancing its suitability for pressing. Following pressing, the modules are carefully removed and placed on pallets for wrapping. This wrapping process is crucial for slow drying ensuring the integrity of the final product.

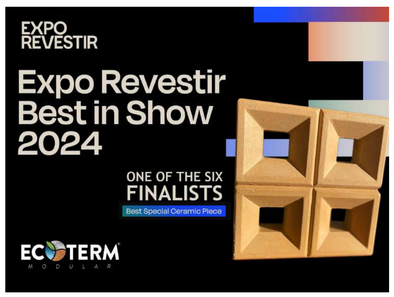
Results

Incorporating appealing designs into CSEBs has substantially elevated their value proposition. Consumers and architects demonstrate a willingness to invest more in these blocks compared to traditional bricks.

Unlike compressed earth interlocking bricks, these feature products do not require specialised trained tradesmen to install, as they can be installed in the same manner as other standard products already available in the traditional construction industry.

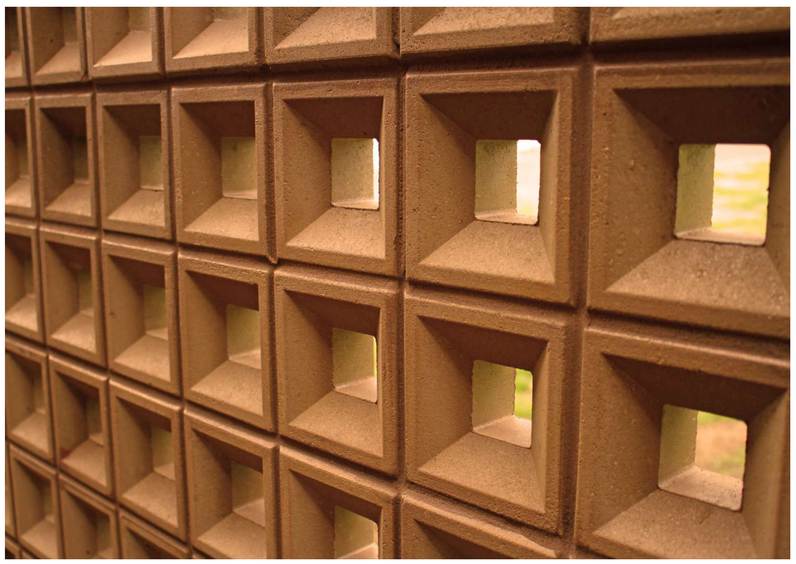
For instance, while manufacturers in Brazil expend similar resources, such as time, raw materials, and labour, to produce both a compressed earth interlocking brick and a breeze block, the market perceives the latter as significantly more valuable. Breeze blocks can fetch prices up to 10 times higher than traditional bricks, exemplifying a strong consumer preference for innovative CSEB designs. While traditional brick production often relies on volume sales for profitability, manufacturers can enhance their revenue streams by diversifying their product offerings. By introducing high-value products like breeze blocks alongside traditional bricks, manufacturers can attract a broader range of consumers and penetrate new markets. This diversification emphasises the versatility and appeal of CSEBs in the architectural landscape.

A signal that this product has been accepted by architects is the nomination of our compressed stabilized earth breeze block as one of the six finalists for the Best In Show award at Latin America's largest coatings and finishings trade fair. With a rich history spanning 20 years, Expo Revestir serves as the primary gathering place for architects, interior designers, construction professionals, and leaders in the building sector.



Conclusion

Ecoterm's innovative efforts in CSEB production showcase the potential for sustainable and economically viable ventures in construction. By transforming production methods and embracing creativity, manufacturers can increase profit margins while contributing to environmental sustainability. These endeavours highlight the importance of sustainable practices in reshaping architectural features for widespread adoption in the earth building sector.



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Grenoble (FRANCE)

BACTERIOPOLIS

ANGELA RUIZ PLAZA - ETSAM SCHOOL OF ARCHITECTURE MADRID - M.A.R.T.E.-SAHALAB

STRATEGIC APPROACHES : BEYOND THE ARCHITECTURAL PROJECT, THE DEVELOPMENT PROJECT

Summary

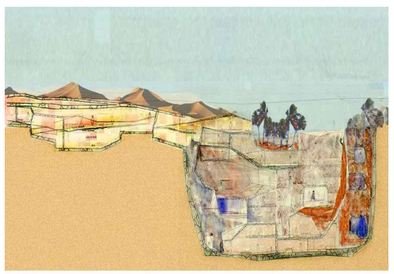
Year 2002. A Sci-Fi artificial oasis project is born at ETSAM: a creative community in a floating architecture in the dunes built with solidified sand.

Year 2020. 20 years later. FORM.M.A.R.T.E. arrives, a community that prepares to inhabit Mars with a Martian Mission Training where Microbiology, Regenerative Architecture and Techno-Ecology come together to build a pilot project in the Sahara desert, in a laboratory of experimentation of a conscious habitation called SAHALAB.

Introduction

Earth construction has an open door to a regenerative future based on new avenues of research through microbiological applications by biocalcification process with bacteria of the Pasteurii family that allow converting Sahara sand into limestone with the help of calcium carbonate and urea.

A research team is working with Sahara sand, river sand and ash from the volcano of La Palma, to test the different possible recipes to generate a new



earth architecture geneated by biocalcification based on the action of bacteria and combined with 3D printing technology merging technology and ecology in a techno-ecology that defends the principles of regenerative architecture.

Methodology

1. An architectural project integrated in the dune, built with solidified sand and biomaterials based on gels that behave as a reactive material of change of state, was designed.

2. An exhaustive field study was carried out in order to know the basic principles of earth construction in the Oasis of southern Morocco.

3. We investigated all the Sustainable Development Strategies that could be implemented in the project based on low-cost mechanisms and the empowerment of the population.

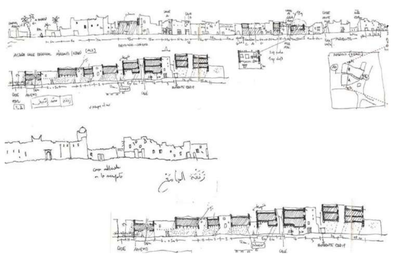
4 The above was shaped as a Doctoral Thesis.

5. A reduced scale dune was projected with the same qualities as the real scale in order to carry out hypotheses of real execution of the solidified dune.

6.Tests were carried out with bacteria solidifying sand, and algae, fungi and cultivated components for the generation of biomaterials of biohorns, biotextiles and solidified mycelium.

7.Parts are built by manual procedures or by 3D printing, testing geometries, sizes and possible morphologies, studying possible dosages of biomortars
.

8.A research-learning community is established to



test models implemented on the blank canvas of the Sahara desert dunes.

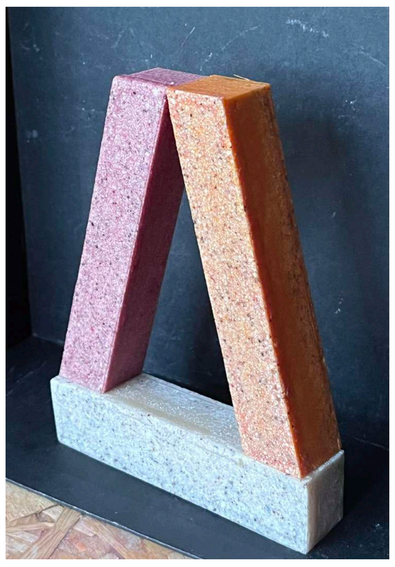
Results

The project hypotheses generated in the workshops with architecture students can derive in long term research lines that involve innovation in architecture and construction with natural materials that can generate a quantum leap in the advancement of bioconstruction.

The contemporary re-reading of traditional systems, the extrapolation of plant and animal mechanisms and their adaptation to extreme climates, is a working system inherited from biomimetic thinking that will create a future of innovative construction.

«The materials of the future will not be manufactured, but cultivated and cooked»

Angela Ruiz



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Mechanical behaviour of Earth Block Masonry in contemporary construction

BALDELLI JACOPO, BOSCATO GIOSUÈ, BARALDI DANIELE, THATIKONDA NANDINI PRIYA, CECCHI ANTONELLA – IUAV UNIVERSITY OF VENICE

CHARACTERIZATION – STANDARDIZATION

Summary

This work introduces an innovative building approach for reinforced Earth Masonry Walls developed in Senegal, focusing on the structural behaviour of earthen masonry. It analyses the mechanical properties of stabilised compressed earth blocks (SCEB) and earth mortar. The blocks are cement-stabilized for improved structural performance and have voids to accommodate reinforcement frames. Experimental campaigns were conducted to assess mechanical properties of constituent materials and the construction system itself. Standard procedure and instrumentation were applied when available. A Finite Element (FE) model, calibrated through the experimental data obtained, was employed to analyse non-linear behaviour of Earth Masonry Wall under compressive loads, employing a macro-modelling approach.

Introduction

Compressed Earth Blocks (CEB) can be described as an evolution of the adobe blocks, compacted for higher performances. In CEBs production, stabilization is a common practice to enhance the physical and mechanical properties of blocks. This study focuses on CEB masonry's mechanical characterisation, analysing constituent materials and construction system. The construction system includes an earth masonry panel with a minimal concrete frame for shear resistance. A frame configuration makes the construction system suitable for seismic areas and enables the construction of taller buildings. Different blocks were designed to allow for the frame to be cast without altering the pattern. Block-1 has two circular holes along its length and Block-2 has lateral semi-circles to cast vertical reinforcements. Block- 3 serves as a channel, acting as permanent formwork for the frame's beam. Block-1 and Block 2 can be used alone to build an unreinforced masonry, while Block-3 it is only necessary to build the reinforced wall. Material composition is given as follows: i) SCEB: sieved red earth, fine sand, and cement (12:6:1), compacted at 3 MPa; ii) Earth mortar: sieved red earth, sand, and cement (3:6:1). A second mortar mix (Mix-1) was also analyzed, consisting of earth mortar (Mix-0) with 1.8% hemp fibers (*l*=20 mm) by dry mass.

Experimental Campaign

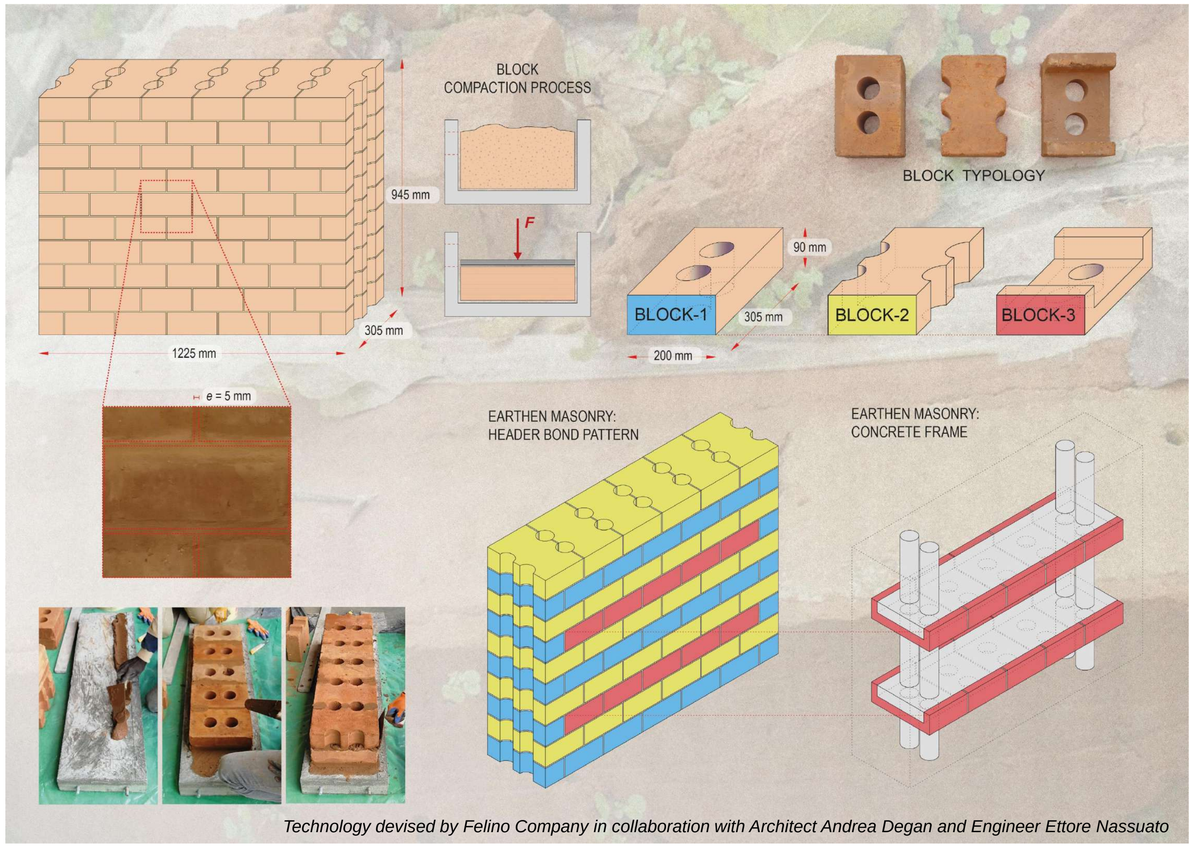
Constituent materials were first tested to evaluate mechanical properties. All tests were performed in displacement control, with a velocity rate of 0,5 mm/min. SCEB were tested in compression in following the literature. Cubic specimens were cut directly from the blocks. Specimen characteristics: mean density ρ_b=1840 kg/m^3; size 90x90x90 mm^3. 13 specimens were tested under compression. Strain was recorded using vertically and horizontally arranged strain gauges. The compressed earth blocks exhibited the following characteristics (mean values): compressive strength σ_b=6 MPa; Poisson coefficient v_b=0,34; elastic modulus E_b=6989 MPa. Mortar flexural strength was determined as per standard (UNI-EN 1015:11). Specimen characteristics: i) Mix-0 mean density ρ_m=1600 kg/m^3, size 40x40x160 mm^3; ii) Mix-1 mean density ρ_m=1566 kg/m^3, size 40x40x160 mm^3. Tests were performed on five specimens of Mix-0 and Mix-1. Flexural strength was determined as 0,6 MPa for Mix-0 and 0,4 for Mix-1. Mortars compressive strength was tested with 40x40x40 mm^3 cubic specimens, cut from the halves of the three-point bending test. Digital Image Correlation (DIC) was used to record vertical strain. The following mechanical properties were identified: i) Mix-0 compressive strength σ_m= 1,3 MPa; elastic modulus E_b=214 MPa ii) Mix-1 compressive strength σ_m=0,9 MPa; elastic modulus E_b=20 MPa. Masonry panels were then tested to evaluate the mechanical behaviour of the construction system under compression loads. Two unreinforced and one reinforced panel were built with 5 mm thick joint of mortar Mix-0. They were tested in displacement control at a velocity of 1,5 mm/min. A markers grid was fixed on the wall surface to extrapolate strains with DIC technique. The mean mechanical properties found are compressive strength σ_w=1,9 MPa; elastic modulus E_b= 2965 MPa. All tests were performed in the Laboratory of Strength of Materials (LabSCo) of the university.

Numerical Analysis

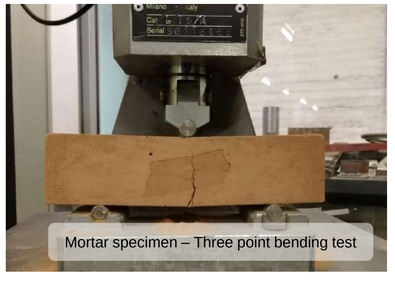
The study utilized a finite element (FE) model with Ansys, employing a macro-modelling strategy. This approach determined the mechanical characteristics of an equivalent orthotropic continuous macro model at a micro level through homogenization. The numerical model investigated the non-linear behavior of the construction system, both with and without the reinforcement frame. A 3D Representative Element Volume (REV) was identified, considering the periodicity of the masonry. Experimental data from SCEB and Mix-0 mortar characterized the block and mortar. Homogenized properties were calculated using Strand7 FE under displacement control. From the numerical analysis, an Elastic Modulus of Eh= 2768 MPa for the unreinforced panels and Eh= 4645 MPa for the reinforced panel was obtained. These properties were used to define the homogenized FE model. Non-linearity was defined using a multilinear law extrapolated from the panels' compression test data of the reinforced and unreinforced specimens. Contact stiffness between elements was calibrated to match experimental behavior, validating the numerical simulation and enhancing its reliability.

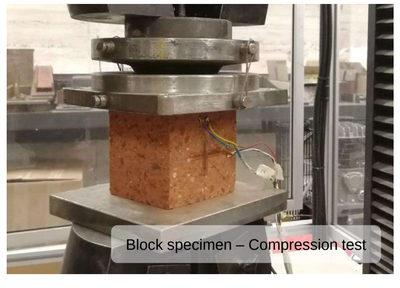
Conclusion

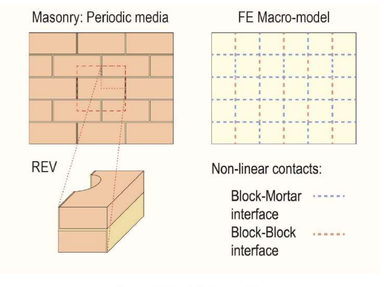
i) Earth cubes exhibit cone-shape crack patterns, the mechanical properties identified are consistent with the literature.
ii) The flexural and compressive strength of mortar specimens from Mix-0 and Mix-1 is comparable, but the elastic modulus of Mix-1 is an order of magnitude lower at higher deformations. This reduction in mechanical performance can be attributed to the high fibre content, which introduces discontinuities in the earth matrix.
iii) The mechanical performance of both reinforced and unreinforced walls under compression does not show significant differences in terms of strength capacity and deformation capacity, as expected.
iv) Without nonlinear parameters describing the mortar-block interface relationship, a multilinear law is an effective method for describing the nonlinear phase of an earth masonry panel.

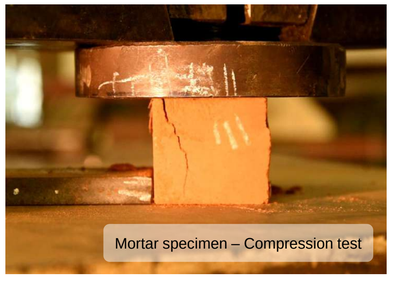


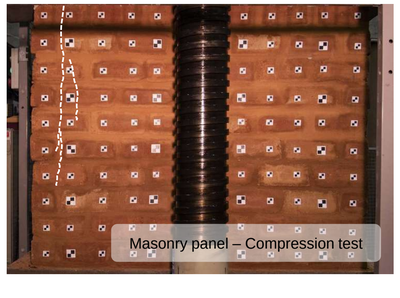
Technology devised by Felino Company in collaboration with Architect Andrea Degan and Engineer Ettore Nassuato

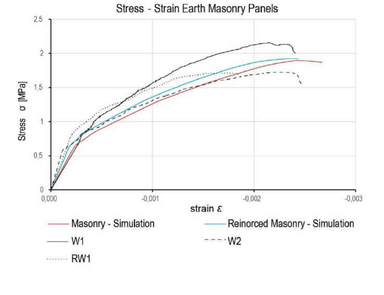

Mortar specimen – Three point bending test


Block specimen – Compression test




Mortar specimen – Compression test


Masonry panel – Compression test



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Fabric Formed Poured Earth™; development of standardized testing

CHARLIE O'GEEN - UNIVERSITY OF MICHIGAN, USA - POURED EARTH COLLABORATIVE

CHARACTERIZATION - STANDARDIZATION

summary

This work outlines methods developed to test the compression and modulus of rupture strengths of Fabric Formed Poured Earth™. Because the drying of this unstabilized material would not occur in standard impervious formworks[1], porous formworks were developed with fabric liners to replicate the casting system used. This poster outlines how the dimensions and testing procedures that were developed for poured earth relate to the previously mentioned New Mexico Earthen Building Materials Code[2] (NM Code) and the New Zealand Standard for the testing of adobe[3] (NZ Standard). The goal of creating a series of standards to measure the strength of Fabric Formed Poured Earth is to make poured earth within the ubiquitous concrete infrastructure more feasible and therefore widespread to elevate earthen construction.

introduction

Portland cement is accelerating climate change. By contributing at least 8% of greenhouse gas emissions worldwide, the cement industry emits more than that of all countries besides the U.S. and China[4]. The production of Portland cement emits .9 pounds of carbon for every pound produced[5]. Alternatively, the concrete industry's robust network can offer infrastructure for natural materials that are nearly zero emissions as long as the material properties are similar when pouring. The Maison des Refugees, the built work of Gauzin-Müller and Fuchs, has proved this possibility by utilizing concrete infrastructure for poured earth, a plastic and castable clay-based material[6]. Previous research by the author combines unstabilized poured earth, with fabric formwork[7]. This research foregrounds that poured earth without Portland cement stabilization takes a prohibitive amount of time to dry in conventional planar impervious formwork and shows shrinkage that is severe enough to produce cracks around the form ties. Instead, the fabric formwork moves with the shrinking material as it dries.

methodology

Currently, no standards exist that specify testing procedures specifically for poured earth. The NM Code outlines standards to test adobe, rammed earth, and compressed earth blocks but does not mention poured earth in the entire text. The NZ Standard does mention poured earth but insinuates that this system is used as small blocks and stipulates that it must be tested as the adobe blocks are tested. Therefore, information was carefully combined from each code to determine an appropriate testing methodology for compression and modulus of rupture tests. Formwork was digitally fabricated from aluminum and plywood to accept a fabric liner.

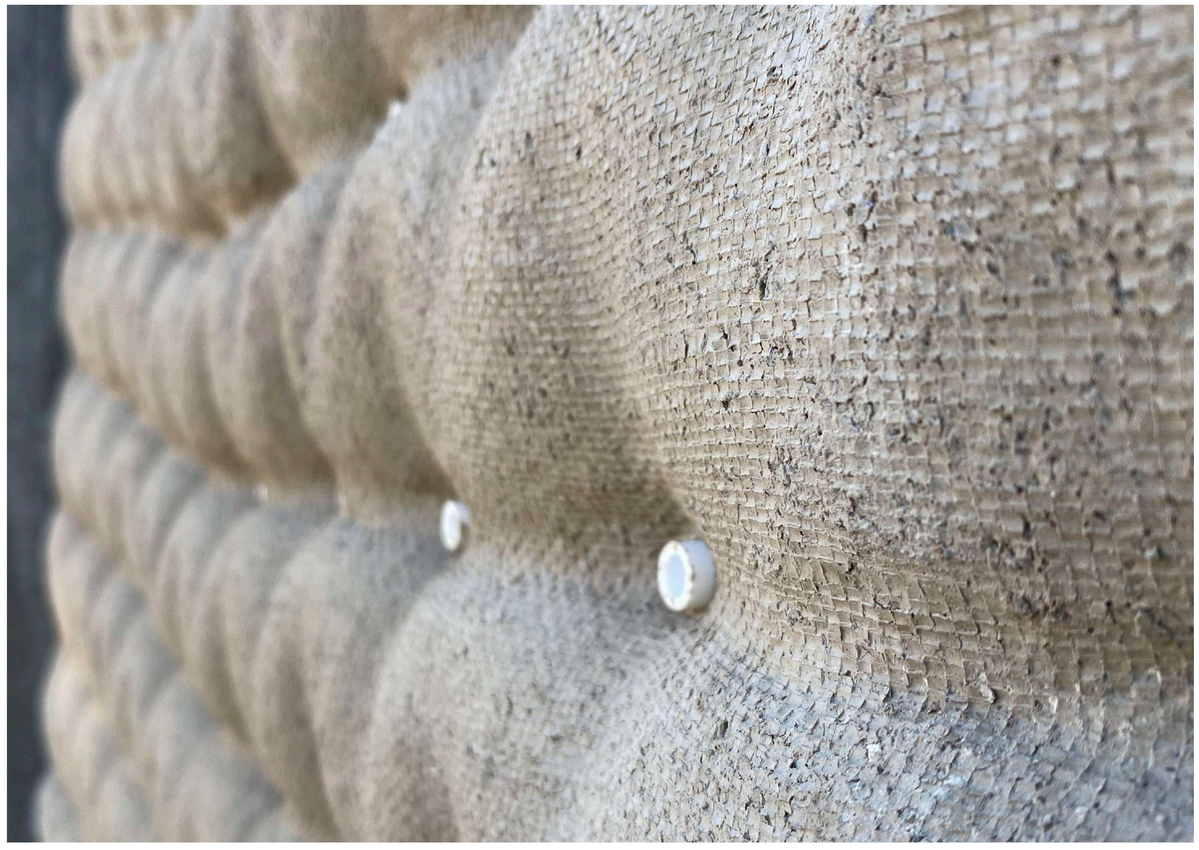
results

After several prototypes and practice tests, the finalized formwork was used to cast samples of Poured Earth with various mixes and water content. The formworks worked as expected, allowing the material to shed water through the fabric and shrink as it desired. After two weeks, the casts were removed from the permeable formwork and dried without being constricted by fabric or formwork. The casts dried for four weeks before being tested (and therefore, destroyed).

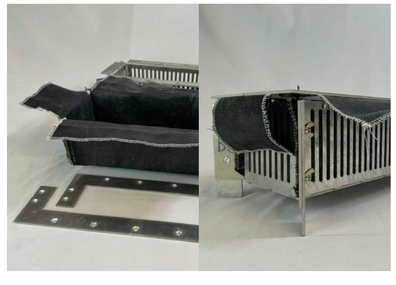
conclusion

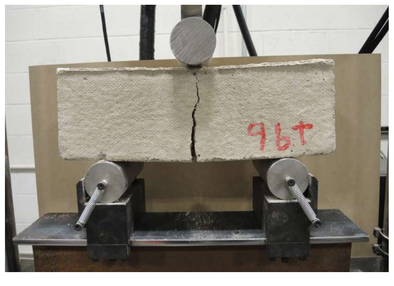
Fabric Formed Poured Earth™ eliminates the need for Portland cement stabilization by allowing excess water to escape and the material to shrink during the drying process. Because of this unique process, a new procedure for testing had to be developed. With the success of this testing process, and the potential to publicly release the fabrication files so that this could be done anywhere in the world, the system could be used to show building officials anywhere that the mix is acceptable, eliminating the need for the environmentally damaging Portland cement.

1 O'Geen, C. and C. P. Harris. 2023. "Fabric Formed Unstabilized Poured Earth: Four-Dimensional Wall Systems", Technology|Architecture+Design, 7:1,109-119.
2 New Mexico Administration Code – Part 4. 2015. New Mexico Earthen Building Materials Code.
3 NZS 4298:2020. 2020. New Zealand Standard – Materials and construction for earth buildings.
4 Gernot Minke. 2006. Building with Earth: Design and Technology of a Sustainable Architecture. Basel: Birkhäuser.
5 (author unnamed). 2020. Think Harder. Concrete: Carbon Footprint. Portland Cement Association: Skokie, Illinois.
6 Gauzin-Müller, D. and M. Fuchs. 2020. "Construire En Terre Coulée: Une Révolution?" D'Architectures: 278.
7 O'Geen, C. and C. P. Harris. 2022. "Fabric Formed Poured Earth: Using Urban Site Soils in Fabric to Eliminate Portland Cement." In Proceedings of the ARCC-EAA Conference, 375–82. Miami, FL, March 2–5.



(above) - texture of completed Fabric Formed Poured Earth™. Note the shrinkage away from the white form tie.
(left) - images showing details of the modulus of rupture test formwork.
(below left) - image showing details of the compression test formwork.
(below) - images showing material being allowed to shrink away from the fabric formwork (left) and water escaping the fabric formwork (right).
(right / below right) - images showing tests being performed.





(below) - image showing a portion of the NM Code being used to determine how to size the test formwork.

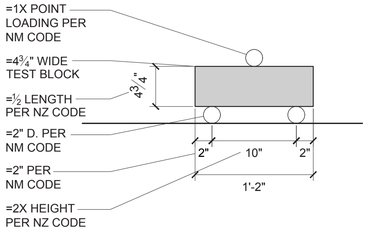
(2) The adobe block shall be tested in the flat position. The length of the test unit must be a minimum of twice the width. The surfaces must be smooth. The test unit shall be **subjected to a uniform compressive load that is gradually increased at a rate of 500 psi/minute** until failure occurs. A true platen should be used in the testing machine, along with swivel head to accommodate nonparallel bearing surfaces. The compressive strength is defined as P/A, where P= load and A = area of compression surface.

D. Modulus of rupture. Cured units shall average 50 psi in modulus of rupture when tested according to the following procedures. A cured unit shall be laid over two-inch diameter cylindrical supports two inches from each end and extending across the full width of the unit. A cylinder two inches in diameter shall be laid midway between and parallel to the supports. Load shall be applied to the cylinder at a rate of 500 psi/minute until rupture occurs. The modulus of rupture is equal to: 3PL/2bt2 (P=rupture load in pounds, L=span between supports, b=width of block, t=thickness of block).

E. Mortar. The use of earth mortar is allowed if the earth mortar material is of the same type as the adobe blocks. Conventional lime/sand/cement mortars of types M, S, and N are also allowed. Mortar "bedding" joints shall be fully grouted, with partially open "head" joints allowable if the surface is to be plastered. All joints shall be lapped at least twenty-five percent of the visible block length.

F. Use. No adobe shall be laid in the wall until fully cured. Adobes shall be laid in level courses so that the top of any course shall be at the same height above the stem around the structure.

(below) - image showing the combination of the NM Code and the NZ Standard to size the modulus of rupture testing.



(below) - image showing the modulus of rupture formwork being waterjet cut out of aluminum.

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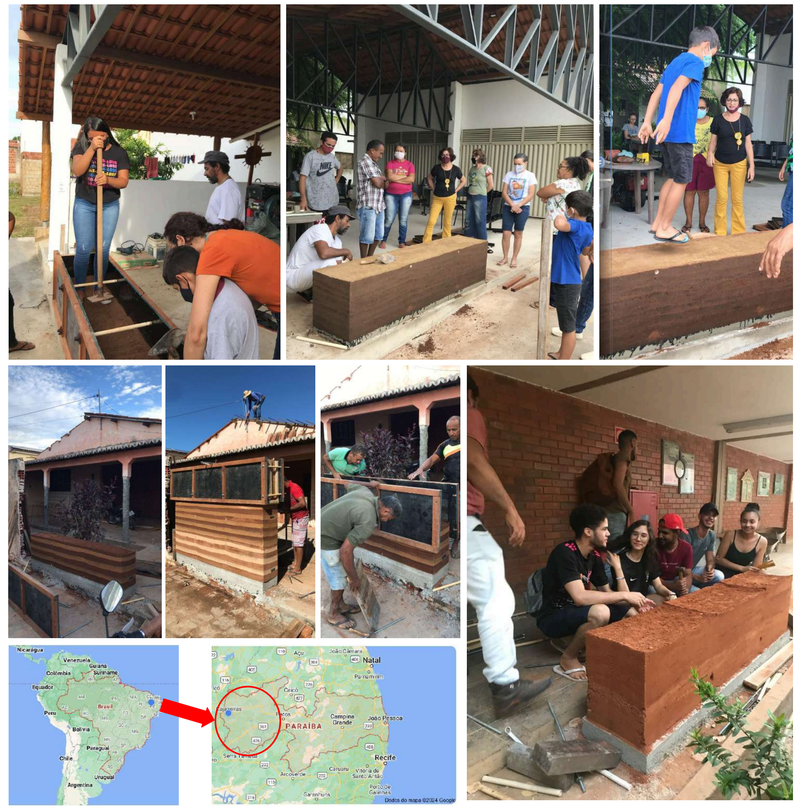
Contexte Comportemental de l'adoption de la construction en terre dans la région semi-aride de Paraíba.

Antonio G. de FARIAS JR - INSTITUTE FEDERALE DE PARAÍBA/ IFPB - LAB CACTUS_CZ
Jaine FERREIRA GOMES - INSTITUTE FEDERALE DE PARAÍBA/ IFPB - LAB CACTUS_CZ
Mariana NICOLAU - CENTRE ON SUSTANABLE COMSUMPION AND PRODUCTION - CSCP
Andressa FERNANDES PINHEIRO - INSTITUTE FEDERALE DE PARAÍBA/ IFPB - LAB CACTUS_CZ

APPROCHES STRATÉGIQUES : AU-DELÀ DU PROJET ARCHITECTURAL, LE PROJET DE DÉVELOPPEMENT



Resumé

La communauté des établissements d'Acauã et de Juazeiro, au Brésil, a été réticente à adopter la construction en terre crue pour un projet de cuisine communautaire, en raison de souvenirs négatifs du passé et de doutes sur la durabilité. Des interventions ont été planifiées, telles que des échanges avec des experts et des ateliers de formation. Ces efforts ont permis d'influencer positivement le changement de comportement, avec l'acceptation du projet de construction en pisé. Des activités ont été menées, telles que la construction d'un mur par un agriculteur et des ateliers avec des étudiants. La diffusion de normes techniques et la construction de mobilier public ont également contribué à sensibiliser la communauté à cette technique de construction durable.

introduction

Il y a une demande croissante pour une construction en terre dans certaines régions du Brésil, face à des problèmes climatiques de plus en plus alarmants. Cependant, il n'existe pas de données précises sur le changement de comportement des personnes qui choisissent désormais de construire avec de la terre crue plutôt que d'opter pour des techniques contemporaines ayant un impact environnemental élevé. Dans le biome de la Caatinga au Brésil, qui souffre depuis des décennies de la dégradation environnementale et des températures élevées tout au long de l'année, cela pourrait être une justification acceptable pour que la population de cette région opte massivement pour l'utilisation de la terre dans ses constructions. Cependant, ce n'est pas ce que l'on observe en visitant les espaces urbains ou ruraux de cette région.

Malgré ce contexte, notre noyau d'extension académique Cactus_cz/IFPB a relevé le défi de proposer l'utilisation de techniques de construction en terre crue dans un projet commandé par des agricultrices pour deux cuisines communautaires dans deux colonies de réforme agraire du sertão de Paraíba.

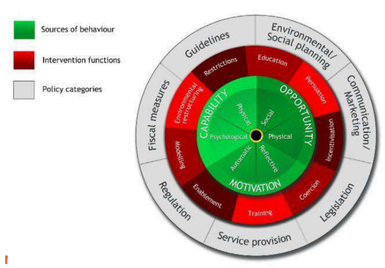
Mais le fait est que la communauté ne voulait pas utiliser de construction en terre de quelque sorte que ce soit et n'a pas accepté la proposition. À partir de ce moment-là, nous avons compris qu'il était nécessaire de comprendre les questions qui entouraient cette décision de la communauté pour savoir s'il y avait quelque chose à notre portée pour planifier et changer cette situation.

La science du comportement a déjà établi qu'il ne faut pas présumer que les gens passent par un processus linéaire pour prendre des décisions, car nous décidons majoritairement de manière irrationnelle. Par conséquent, lors de la planification d'interventions visant à provoquer un changement de comportement, il est important de connaître au préalable les bases qui sous-tendent ce comportement afin de pouvoir choisir les stratégies et techniques appropriées pour l'efficacité de cette intervention. Selon Michie et al. (2011), "il existe déjà des preuves que la caractérisation des interventions à travers les techniques de changement de comportement peut être utile pour comprendre quelles interventions sont plus ou moins efficaces". Dans ce sens, cet article vise à caractériser le contexte comportemental pour l'adoption de constructions en terre dans la région semi-aride de Paraíba.

méthodologie

Comme procédure méthodologique pour systématiser les observations réalisées sur ce phénomène, nous utiliserons l'outil COM-B, acronyme de Capacité, Opportunité, Motivation - Comportement proposé par Michie et al. comme une ressource structurée pour cartographier à travers les perspectives individuelle, sociale et environnementale du comportement cible.

Cette structure de données permettra de caractériser l'origine du comportement selon trois axes en fonction de sa capacité, de son opportunité ou de sa motivation à le modifier. En identifiant la cible du changement de comportement souhaité, il est possible de déterminer parmi 9 types d'interventions celui qui correspond le mieux à l'action planifiée. Enfin, l'outil propose 7 politiques à mettre en œuvre pour permettre que l'intervention puisse se dérouler dans l'environnement approprié. La collecte de données a été divisée en deux moments : d'abord, une focalisation sur l'identification et le diagnostic des raisons pour lesquelles la communauté n'accepte pas les techniques de construction en terre crue, où des entretiens ouverts ont été menés avec les dirigeants des groupes communautaires ; ensuite, l'application d'interventions à deux groupes focaux hétérogènes qui ont participé à deux sessions de formation sur la construction en pisé. La première session était axée sur les acteurs du secteur de la construction et les agriculteurs, et a eu lieu au siège de l'association des agriculteurs. La seconde session était destinée aux étudiants en architecture et en génie civil à l'Institut fédéral de Paraíba - IFPB/Campus Cajazeiras, dans le cadre de l'événement académique "Chantier-École", qui vise à offrir des expériences pratiques en tant que stratégies pédagogiques d'apprentissage sur les constructions à faible impact environnemental.



Les résultats des entretiens avec les dirigeants communautaires ont permis d'identifier les lacunes qui empêchent l'adoption de la construction en terre crue pour le projet de cuisine communautaire proposé.

La communauté des établissements d'Acauã et de Juazeiro, où les projets ont été proposés, conservait un certain nombre de souvenirs affectifs négatifs concernant les constructions en terre crue, tels que les souvenirs du temps où elles avaient construit des maisons en torchis il y a des années lors des années de campement pour occuper la zone rurale non productive de la ferme où l'établissement a été créé. Un autre point saillant était les doutes concernant la durabilité des maçonneries, et étant donné qu'il s'agissait d'un projet de cuisine, les femmes de l'établissement craignaient que le projet ne soit pas approuvé par les organismes de réglementation, ce qui était donc le contexte dans lequel le comportement était inséré.

En collaboration avec la communauté, plusieurs interventions ont été planifiées dans le but d'influencer le changement de comportement afin que la communauté décide d'utiliser ou non les techniques de construction en terre crue. Ainsi, quatre types d'interventions ont été identifiés, axés sur l'éducation, la persuasion, la formation et l'incitation. Après les activités, la communauté a accepté de réaliser le projet avec la technique du pisé. Un des agriculteurs ayant participé à l'un des ateliers a accepté l'invitation pour construire un mur dans une maison en rénovation afin d'expérimenter la technique dans un autre contexte, et cela est présenté dans le tableau à côté.

Conclusion

Les interventions ont été capables de provoquer un changement de comportement, amenant la communauté à accepter que le projet de cuisine communautaire soit planifié avec la technique du pisé. À travers l'outil COM-B, nous avons pu comprendre que le contexte comportemental a utilisé 4 des 9 fonctions qu'une intervention peut assumer, et qu'une seule action politique axée sur la communication/marketing, bien qu'ayant provoqué un changement de comportement, semble être insuffisante pour augmenter l'échelle de l'adoption, car aucune autre action réalisée spontanément par les autres acteurs participant aux activités n'a été identifiée. Par conséquent, il convient d'explorer des activités qui ciblent les autres fonctions et politiques prévues dans la méthode proposée, ainsi que dans de nouveaux contextes.

Images de l'agriculteur qui a accepté le défi de participer à la construction du mur en pisé lors d'une rénovation résidentielle et de l'atelier avec les étudiants de l'IFPB et l'atelier avec les agriculteur.

cible du changement de comportement adoption de maçonneries en terre crue

Context: souvenirs affectifs négatifs concernant l'utilisation du torchis
doutes concernant la durabilité des maçonneries
peur de ne pas être approuvé par les organismes compétents

Code du table:
Interventions : Éducation, Persuasion, Incitation, Contrainte, Formation, Restriction, Restructuration environnementale, Modélisation, Possibilités/moyens, Non classifiable
Politiques : Fiscale, Communication/marketing, Prestation de services, Législation, Réglementation, Directives, Planification environnementale/social, Non classifiable

intervention	function de l'intervention	politiques
Réaliser un échange avec un spécialiste de la construction en terre.		
1. Présenter une autre technique de construction en terre crue différente du torchis.	Persuasion	Communication/marketing
2. Réunion en ligne avec un spécialiste en permaculture ayant de l'expérience en pisé.	Éducation	
Organiser un atelier de montage de mobilier en pisé.		
1. Enseigner le processus de sélection du sol où les agriculteurs apporteraier la terre de leur propre zone rurale.	Formation	Communication/marketing
Comprendre le processus de montage des moules et de compactage de la terre pour un groupe d'agriculteurs.	Formation	
2. Publier des vidéos sur le développement des activités proposées.	Persuasion	Communication/marketing
3. Publier des articles scientifiques lors de congrès.	Éducation	Communication/marketing
Construire un mur dans une résidence.		
1. Proposer le défi a un agriculteur de participer a la construction d'une structure verticalisée.	Incitation	
2. Utiliser la technique de construction en terre dans un environnement de travail du marché.	Persuasion	
Organiser un atelier pour la construction d'éléments en porte-à-faux.		
1. Diffuser la norme technique sur la technique du pisé.	Éducation	Communication/marketing
2. Produire la construction d'un mobilier dans un lieu public de la communaut afin que tous puissent y avoir accès.	Persuasion	

référence

MICHIE, S.; VAN STRALEN, M. M.; WEST, R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. **Implementation Science**, v. 6, n. 1, p. 42, 23 abr. 2011.

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A study on the proposal of Korea's Earth-concrete construction method based on two case studies.

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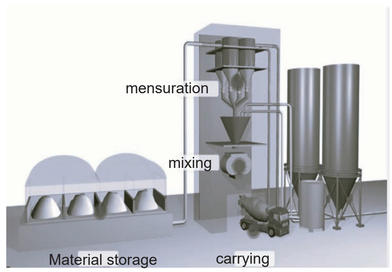
7. Strateg,ic approaches : beyond the architectural project, the development project

introduction

In Korea, reinforced concrete pouring has been a common construction method since 1910 and has rapidly developed to replace wood construction. This method has the most construction infra-structure in the country due to its advantages in construction period, constructability, and economy.
However, the weakness is that cement produc-tion produces a lot of carbon emissions, which contributes to the climate crisis and makes it a less sustainable material. Therefore, various new construction technologies are being devel-oped to replace cement, but they are not unive-rsally applied due to economic factors and lack of infrastructure to apply the methods.
Earth, a low-carbon building material of the fut-ure, can be an alternative as a future building material, and an easy-to-apply earth constructi-on method is the earth concrete pouring method, which replaces cement with high-performance lime and earth. Therefore, this study presents two cases of earth concrete pouring method using earth as a material.

Description of the reinforced concrete construction system



Description of the reinforced concrete construction system

methodology

The earth reinforced concrete pouring method is not much different from the reinforced concrete construc-tion method, which has been built for over 100 years in Korea, so it can be easily applied to construction period, constructability, material supply, etc. by utilizing the ready-mixed concrete infrastructure in all regions of Korea. Especially, construction methods that replace cement with high-performance lime and earth can significantly reduce the cost of building new infrastructure, and the use of earth as a building material is expected to be realized more quickly. This study introduces cases of buildings that apply low-carbon earth reinforced concrete construction using ready-mixed concrete infrastructure and construction methods that have become common in all regions of Korea, and suggests the problems, development directions, and expected effects of each site.

1 case :Construction process

Foundation

Formwork

Steel reinforcement

Mixing

Pouring

Formwork Removal

case study 1

The first case is a small-scale residential structure in the earthen village of Seung-dal Mountain in Muanan-gun, Jeollanam-do, South Korea.
The building was constructed with reinforced poured-in-place concrete in accordance with the earthquake-resistant design, replaced all cement in the concrete mix with high-performance lime and earth.
The building used of euroform formwork, reduced the economic cost of developing new construction methods and constructed a suitable the building of South Korea's seismic performance require-ments. (South Korea has required seismic perfor-mance for all residential buildings since 2010.) This building is a private residential building, and unlike public buildings, it was constructed with cement concrete only for the foundation, while the walls and roof were constructed with earthen reinforced-concrete without cement.
To pour the soil, it was difficult to apply ready-mixed concrete, so construction equipment such as excavators and pump cars were used.
Due to the low volume of earth concrete and the difficulty of cleaning up when using earth, the ready-mixed concrete company complained of difficulties such as cleaning, so dump trucks and excavators were used to mix and pour.
The completed building is an example of earth construction, using reinforced concrete, no ce-ment, and earth as a seismically resistant structure.

Finishing

case study 2

The second case is a public building application, a three-story cultural workspace in Gokseong-gun, Jeollanam-do, South Korea.
The building was completed in 2023, and the process of negotiating with local ready-mix con-crete companies from the design stage on how to reduce cement and add earth to the mix, and finding the right proportion of earth to add, was different from other buildings.
It is an earth concrete construction,
and it was a challenge to convince public official that the use of earth as a building material is significant for the future. It is designed with exposed reinforced concrete, and the color of the natural materials used is different from cement concrete. In addition, the building is constructed masonry construction with non-fired earth brick and rammed earth as nonload-bearing walls, and various methods of earth construction were applied to show the unique charm of earth.

2 case :PLAN

2 case :Construction process

Foundation

Formwork

consulting

test

results

First, earth is expected to significantly reduce carbon emissions by replacing cement, the largest contributor to carbon emissions in construction, with earth and high-performance lime.
Second, this study confirmed the possibility of field application of the reinforced earth concrete meth-od, which replaces cement with earth in the gene-ralized reinforced concrete method, through two cases of construction using earth. By expanding the application of earthen architecture to public buildings as well as small-scale buildings, it has become easier to apply modern construction me-thods using traditionally used earthen rather than new earthen materials, and has become a good example of how much interest in earthen materials can be realized in Korea.
Third, this study shows that active research and social consensus are needed to solve institutional problems such as Korean building codes, unlega-lized specifications, and small-scale construction projects that are difficult to apply in the existing ready-mixed concrete infrastructure.

Pouring

Formwork Removal

On the future, it is believed that earthen concrete can be an alternative to reinforced earthen conc-rete with existing ready-mixed concrete infrastruc-ture, showing the possibility of developing into a more economical construction method and beco-ming a new future construction method with vari-ous development models of earth architecture in Korea.

conclusion

Expectations and future research

Through this study, the reinforced earth concrete method is expected to realize various designs that are the advantages of the existing reinforced con-crete method, and it is expected to be more easily applied to the exposed concrete method, which is widely used in Korea.
Through this study, it is expected that more rese-arch is needed to ensure universal application through institutional complements such as Korean building codes, incentive systems as eco-friendly construction methods, and complementary specifications.